A Prospective Study Of

SHORT TERM ANALYSIS OF THE FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL FEMORAL FRACTURES FIXED WITH LOCKING COMPRESSION PLATE BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS (MIPO) TECHNIQUE

Dissertation submitted to

THE TAMILNADU DR M.G.R. MEDICAL UNIVERSITY

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In partial fulfilment of the regulations for the
Award of the degree of

M.S. (ORTHOPAEDIC SURGERY)

BRANCH - II

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CHENNAI - 600 010

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CERTIFICATE

This is to certify that **Dr. SIVAPRASATH. J**, post graduate student (2011-2014) in the Department of Orthopaedic Surgery, Kilpauk Medical College, has done the dissertation on **"A PROSPECTIVE STUDY OF SHORT TERM ANALYSIS OF THE FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL FEMORAL FRACTURES FIXED WITH LOCKING COMPRESSION PLATE BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS (MIPO) TECHNIQUE"** Under my guidance and supervision in partial fulfilment of the regulations laid down by the 'THE TAMILNADU DR M.G.R MEDICAL UNIVERSITY, CHENNAI – 32' for M.S. (Orthopaedic Surgery) degree examination to be held in April 2014.

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DECLARATION

I, **Dr. SIVAPRASATH. J,** solemnly, declare that this dissertation titled **"A PROSPECTIVE STUDY OF SHORT TERM ANALYSIS OF THE FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL FEMORAL FRACTURES FIXED WITH LOCKING COMPRESSION PLATE BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS (MIPO) TECHNIQUE "** is a Bonafide work done by me at Kilpauk Medical College, during the period from 2011 to 2014, under the guidance and supervision of my Unit Chief and Head of the Department, **Prof. N. NAZEER AHMED, M.S. (Ortho), D.Ortho,** This dissertation is submitted to "THE TAMILNADU DR MGR MEDICAL UNIVERSITY", towards partial fulfilment of regulations for the award of M.S.DEGREE BRANCH II in Orthopaedic Surgery.

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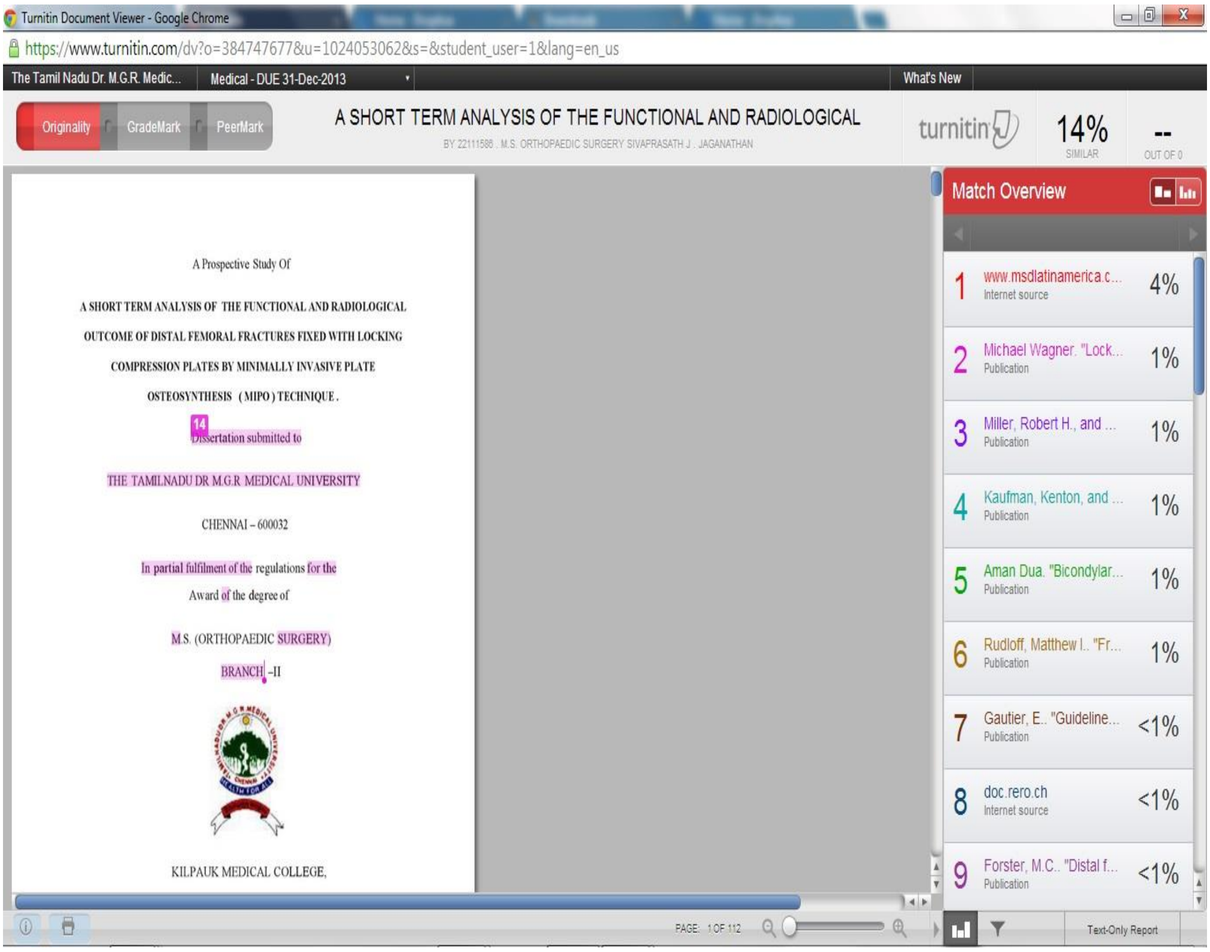

LIST OF ABBREVIATIONS :

LCP	- Locking compression plate
MIPO	- Minimally invasive plate osteosynthesis
LCP-DF	- Locking compression plate – Distal femur
PC – FIX	- Point Contact Fixator
LHS	- Locking head screws
ROM	- Range of movements
KSS	- Knee society score
LISS	- Less invasive skeletal stabilization
ORIF	- Open reduction & Internal fixation
AP	- Antero posterior

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ABSTRACT:

Title: A prospective study of short term analysis of the functional and radiological outcome of distal femoral fractures fixed with locking compression plate by minimally invasive plate osteosynthesis (MIPO) technique.

Keywords: Distal femur fractures, minimally invasive, indirect reduction techniques, MIPO, knee society score, locking compression plate

Aim: To prospectively analyse the clinical and radiological outcome of distal femur fractures fixed with locking compression plate by minimally invasive plate osteosynthesis (MIPO) technique.

Materials and methods: 20 patients with distal femur fractures were evaluated in between July 2011 to November 2013. Radiographs of knee were taken in AP & Lateral views. AO/Muller type B and C3 were excluded from the study. All the patients were operated under spinal/epidural anaesthesia and the patient position was supine with knee in 60-70 degrees flexion. Distal femur was exposed using modified lateral approach (minimally invasive) and the fracture was reduced by indirect reduction techniques. We used locking compression plate to fix the fracture. Post operative radiographs were taken to assess the reduction and implant position.post operative rehabilitation was started from the 1st post operative day. Patients were followed up at every 4-6 weeks interval to assess fracture union, limb length, alignment, knee range of movements and functional outcome. Hammer et al grading was used to assess union and the knee society scoring system was used to assess the functional outcome.

Observations and results: We followed up 20 patients in the age group of 20 – 80 years for the period of 6 to 18 months (mean =12 months). Among them, 13 patients were males and 7 females; 12 patients sustained RTA and 8 had a self fall. 5 patients sustained an open fracture with 2 had grade I and 3 had grade II injuries. 15 of them had type A fractures (A1-3, A2-4, A3-8) and remaining 5 had type C fractures (C1-1, C2-4). The mean interval for surgery was 5 days and the mean operating time was 101 minutes. The length and rotation was not altered in any of our patients. Union was achieved in all the patients and the mean time to union was 15 weeks. The average knee flexion achieved at the final follow up was 91.7 degrees. Full extension was achieved in 17 of our patients. We had the following complications, loss of reduction (n=1); infection (n=1), post operative DVT (n=1), knee stiffness (n=1) and reactive synovitis (n=1). The average knee society score was 153 and 75 % of our patients had good to excellent results.

Conclusion: From our study, we conclude that the Minimally Invasive Plate Osteosynthesis (MIPO) technique using Locking Compression Plate (LCP) will results in early post- operative rehabilitation, satisfactory union and good functional outcome. The chances of infection and implant failure are less. Proper patient selection and meticulous surgical techniques will give the best results.

INTRODUCTION

Fractures of distal femur are very complex injuries and there is significant difficulty to manage. These injuries are severe and have a potential to produce long term disability. These fractures often are unstable and comminuted and tend to occur in elderly or multiply-injured patients.

The fractures of distal femur account for 7% of all femoral fractures. If Hip fractures are excluded, 31% of fractures involve the distal femur. The fractures involving distal 15 cm of femur including distal femoral metaphysis (supracondylar) and articular surface (intercondylar) are classified as distal femur fractures. [(1)]

Distal femur fractures exhibits bimodal age distribution. In young adults it occurs due to high velocity trauma like road traffic accidents. These patients often sustain multiple and compound injuries. Older patients sustain distal femur fractures mostly due to trivial fall occurring in elderly osteoporotic bone.

In 1960's most of these fractures were treated conservatively and documented better outcome than operative treatment. But with the advent of newer implants and modern techniques, these fractures are best treated with surgical stabilization. The newer modalities of treatment include minimally invasive plate osteosynthesis (MIPO) and less invasive skeletal stabilization (LISS). [(1)]

Hence in the Department of Orthopaedic surgery at Kilpauk medical college and Hospital, Chennai; a prospective study was conducted to analyse the functional and radiological outcome of distal femoral fractures fixed with locking compression plate by minimally invasive plate osteosynthesis (MIPO) technique.

AIM AND OBJECTIVE

To evaluate twenty cases of distal femur fractures fixed with locking compression plate by minimally invasive plate osteosynthesis (MIPO) technique in the Department of Orthopaedic surgery at Kilpauk medical college and Hospital, Chennai between JULY 2011 to NOVEMBER 2013.

To prospectively analyse the clinical and radiological outcome of the above procedure.

ANATOMY

The distal end of femur has two condyles which are partly articular acts as a bearing surface for transmission of weight to the tibia. The condyles unite anteriorly and continue as shaft; posteriorly they are separated by a deep intercondylar fossa. The U shaped broad articular area articulates with patella and tibia. The medial condyle is longer than the lateral one and extends farther distally. [2] [3] [4]

Patellar surface (Trochlear groove)

In between the two condyles there is a shallow groove anteriorly known as trochlear groove, which articulates with the patella. The trochlear groove helps to stabilize the patella. The lateral groove is more distinct than the medial groove. The abnormally shallow groove leads to instability.

Intercondylar fossa

The intercondylar fossa separates the two femoral condyles distally and posteriorly. It is intracapsular but largely extra synovial structure.

Lateral condyle

The lateral femoral condyle is broader anteroposteriorly than medial condyle. The most prominent point of lateral condyle is lateral epicondyle, where lateral collateral ligament attaches. The tendon of popliteus runs deep to the lateral collateral ligament and inserts anteroinferior to the lateral epicondyle. Lateral condyle is intracapsular and largely intrasynovial except for the attachment of popliteus. The lateral surface of lateral condyle projects beyond the shaft. Its medial surface forms lateral wall of the intercondylar fossa.

Medial condyle

The medial border of the medial condyle is convex, which is easily palpable. The medial prominence is called as medial epicondyle and gives attachment to the medial collateral ligament. Proximal to it is a facet called adductor tubercle to which adductor magnus muscle inserts. The lateral surface of medial condyle forms medial wall of the intercondylar fossa. Even though the shaft is oblique, the alignment of condyles makes distal end almost horizontal.

Soft tissues [1]

There are three major groups of muscles in thigh

- Hip adductors
- Knee extensors
- Knee flexors

The knee extensors and flexors cross the knee joint and it is integral to its function. Quadriceps muscle lies anteriorly, constituting the extensor apparatus supplied by the femoral nerve. Hamstring muscles that flex the knee lies posteriorly and supplied by sciatic nerve.

The femoral vessels run in the Hunter’s canal between the extensor and adductor compartment, below the Sartorius muscle. The femoral vessels pierce the adductor magnus and enter the posterior compartment 10 cm above the knee joint. In the popliteal fossa it joins the sciatic nerve and renamed as popliteal vessels and the sciatic nerve branches into tibial and peroneal nerves. Within the popliteal fossa artery lies medial and deep to the vein and tibial nerve.

The attachments of lateral condyle are

- The lateral collateral ligament of knee joint attaches to lateral epicondyle
- Tendon of popliteus antero inferior to lateral collateral ligament insertion
- The lateral head of gastrocnemius
- The plantaris

The attachments of medial condyle are

- Medial collateral ligament attaches to medial epicondyle
- Adductor magnus inserts into the adductor tubercle
- Medial head of gastrocnemius just above the medial condyle

The attachments to intercondylar fossa

- Anterior cruciate ligament to the small oval facet on the medial surface of lateral femoral condyle.
- Posterior cruciate ligament to the large oval facet on the lateral surface of medial femoral condyle.
- Capsular ligament of oblique popliteal ligament attaches to the posterior intercondylar line.

- Infrapatellar synovial fold attaches to the anterior border of intercondylar fossa.

The Supracondylar area

The Supracondylar area of the femur comprises of zone between the condyles and the metaphyseo diaphyseal junction.This comprises of distal 9 to 15 cm of the femur. It contains the lateral and medial supracondylar lines, anterior and popliteal surfaces.

The attachments to the lateral supracondylar line

- Short head of biceps femoris
- Lateral intermuscular septum
- The plantaris

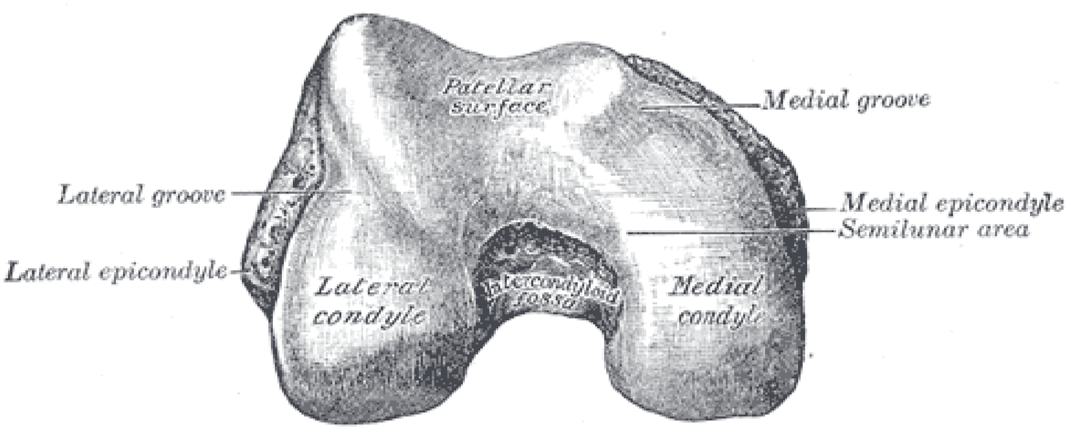


Fig 1. Anatomy of condylar surface

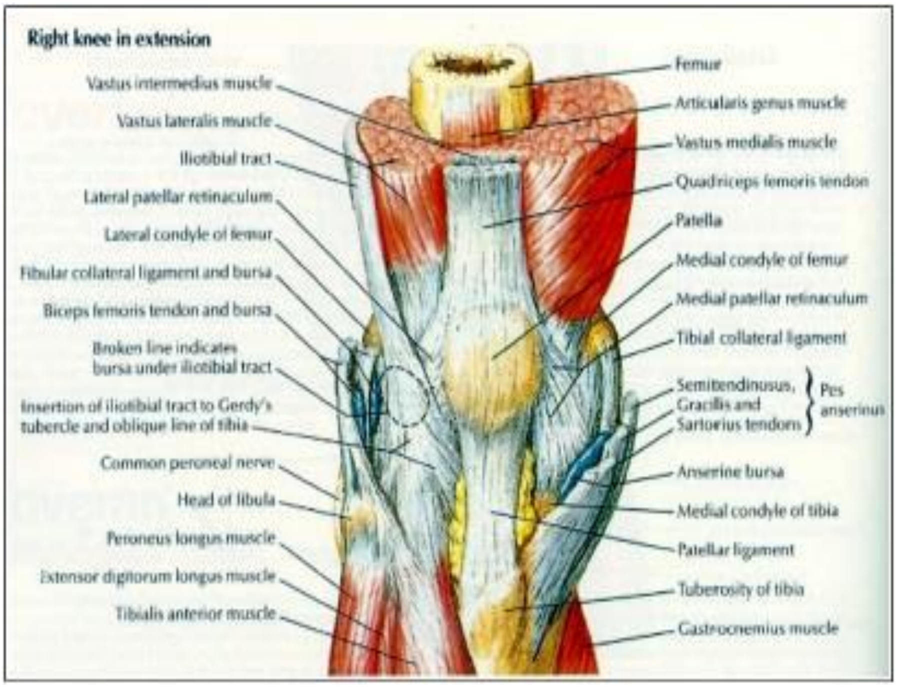


Fig 2. Soft tissue around distal femur anterior view

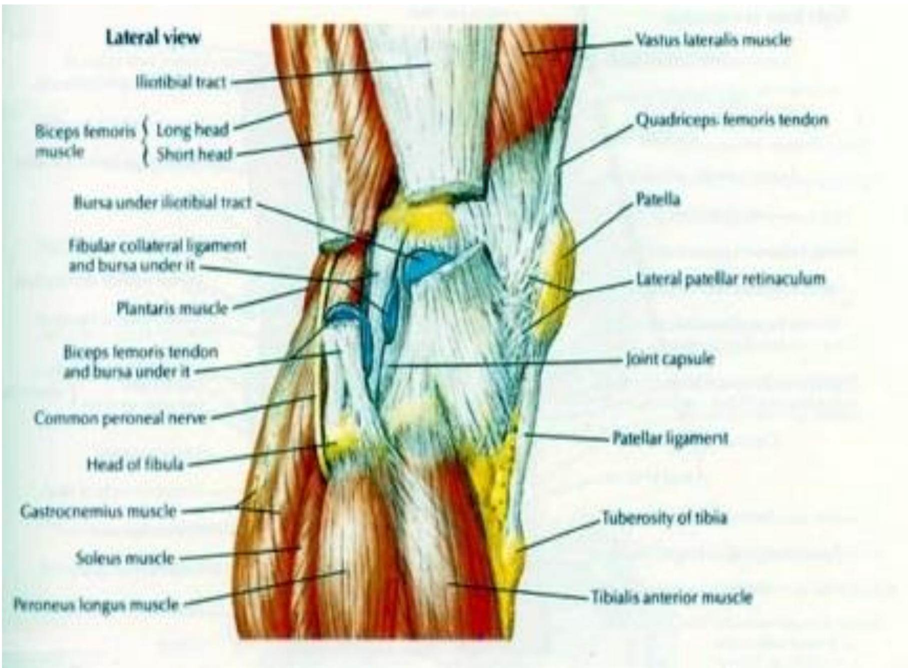


Fig 3. Soft tissue around distal femur lateral view

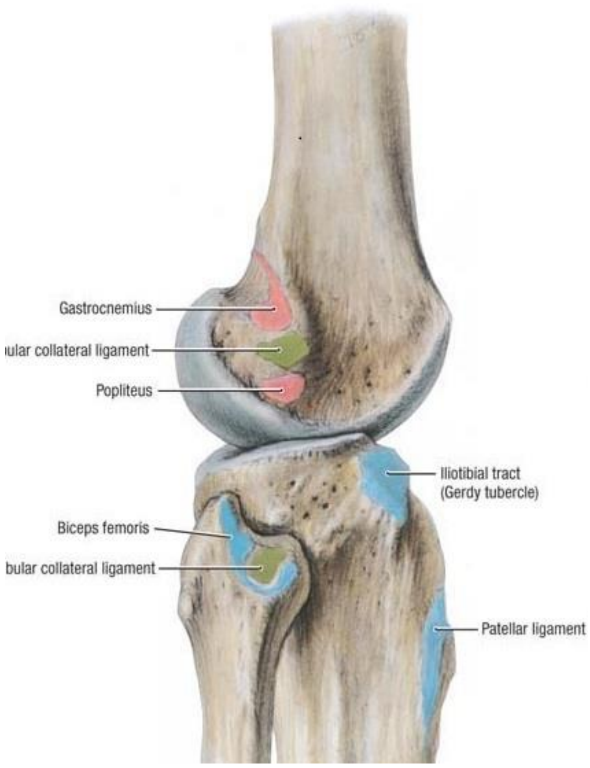


Fig 4.The attachments to the lateral condyle of femur and tibia

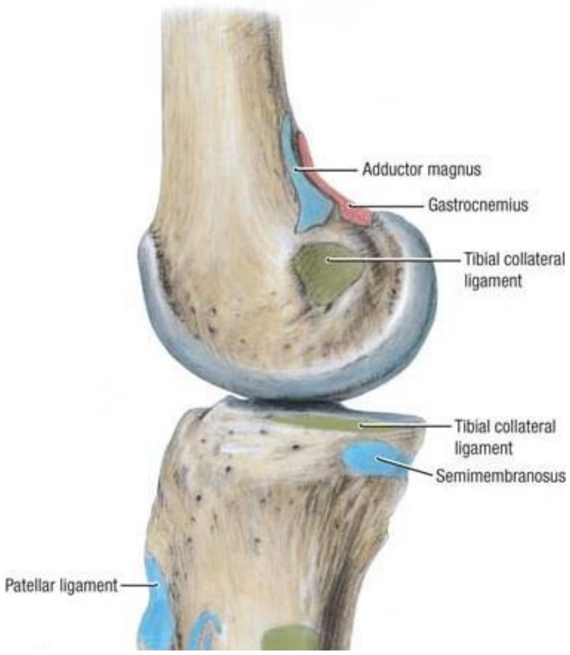


Fig 5.The attachments to the medial condyle of femur and tibia

The attachments to the medial supracondylar line

- Vastus medialis
- Membranous expansion of tendon of the adductor magnus.

Blood supply [5], [5]

Distal femur receives its blood supply from osseous branches of genicular arteries. The distal femur receives rich blood supply due to collaterals forming the anastomoses around the knee joint. The extra osseous blood supply to the lateral femoral condyle by the superior and inferior lateral genicular arteries, superior medial genicular artery and lesser branches of the popliteal artery combine to supply medial femoral condyle.

Nutrient artery to the femur

A branch of second perforating artery enters the nutrient foramina located on the medial side of the linea aspera and it is directed upwards. Intraosseous supply to the lateral condyle is by the arcade of vessels giving multiple branches to the subchondral bone and the medial condyle is supplied by a single nutrient vessel with apparent watershed area of limited supply.

Venous and lymphatic drainage

The venous drainage of the distal femur is by the corresponding genicular veins which drain into femoral vein. The lymphatics accompany the genicular veins and drains into popliteal and deep inguinal group of lymph nodes.

Ossification [3]

Femur is the second bone to ossify next to the clavicle and it has one primary and four secondary ossification centres.

Primary centre

- Shaft appears in 7th week of intra uterine life.

Secondary centres

- Distal femur – 9th month of foetal life
- The head - 1st year
- The greater trochanter - 4th year
- The lesser trochanter - 13th year

There are three epiphyses in the proximal part and one at the distal end. The distal femoral epiphysis fuse by 18-20 years. Patella ossifies from many centres which appear during 3-6 years of age, fusion becoming complete at puberty.

Neurovascular structures in relation to the distal femur

The femoral artery and the femoral vein lies posterior to the distal femur which continues as popliteal vessels in the popliteal fossa. The sciatic nerve which divides into the tibial nerve and common peroneal nerve lies lateral to the femoral vessels and posterior in relation to the distal femur. There is a risk of injury to these structures either a direct injury or compression by the fractured fragment due to posterior angulation of distal fragment due to the pull of hamstrings.

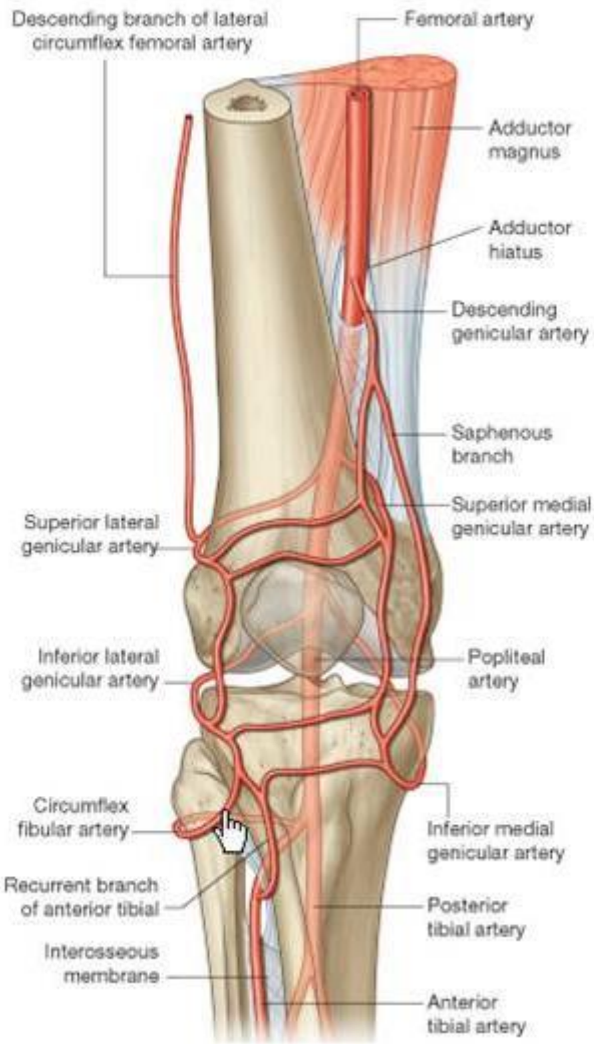


Fig 6.Vascular structures in relation to distal femur

BIOMECHANICS OF DISTAL FEMUR

Normally the knee joint is parallel to the ground and the ankle joint. The expanded femoral and tibial condyles are adopted for the direct downward transmission of weight. The normal anatomic axis has a valgus angulation of 9^{o}, which ranges between 7 to 11 degrees. Anatomic axis is the angle made between the shaft of the femur to the knee joint. This tibiofemoral shaft angle is called the physiological valgus.

In an end on view, distal femur is trapezoidal with an angle of inclination of the medial surface of 25 degrees and lateral surface has 10 degrees. The patellofemoral inclination also measures 10 degrees. This plays a vital role during placements of implants; the implants that appear appropriate in radiograph may be clinically long causing painful irritation. (6)

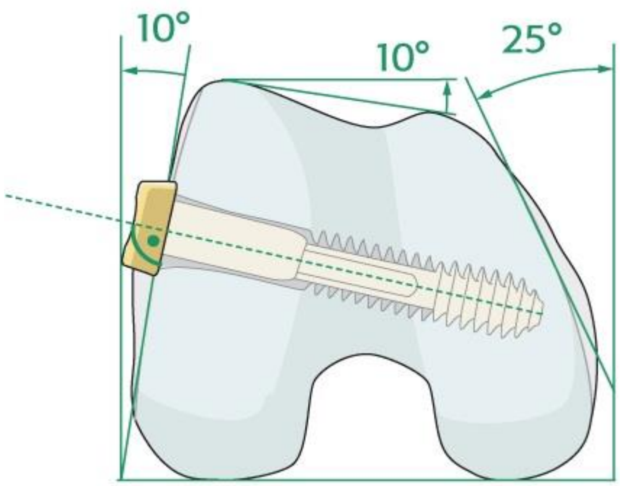


Fig 7.End on view – Distal femur

Axis of femur [7]

Vertical line dropped from the symphysis pubis perpendicular to the ground is known as the vertical axis. Line drawn from centre of the femoral head to that of ankle joint is known as the mechanical axis. It passes through the knee joint just medial to the tibial spine. The mechanical axis makes 3 degree valgus to the vertical axis. The line drawn along the length of centre of medullary canal of femur and tibia makes anatomical axis. Usually the anatomical and mechanical axis of tibia is the same but the former makes an angle of 5 to 7 degrees of valgus with mechanical axis and 9 degree of valgus to vertical axis.`

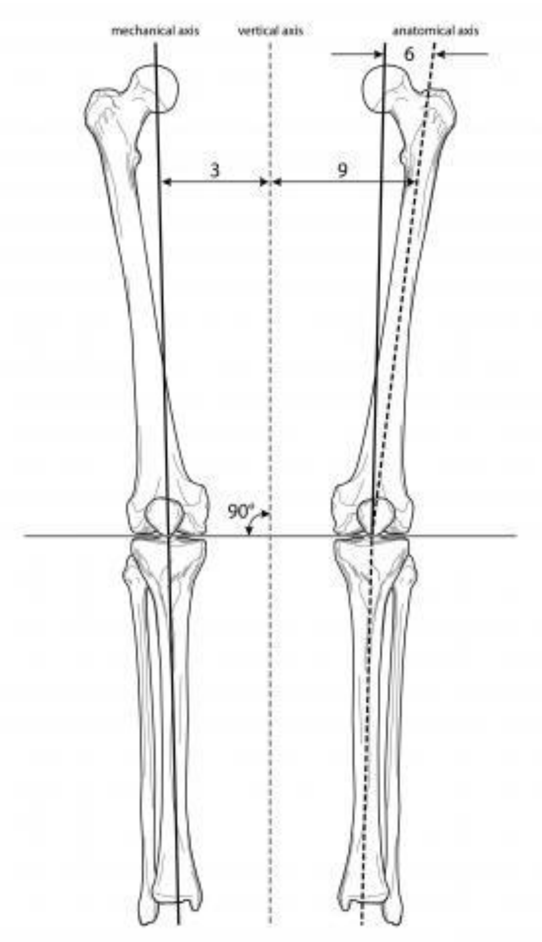


Fig 8. Axis of femur

Geometry of articulating surfaces [8]

The widths of tibial plateau are greater than that of corresponding femoral condyles. But the depths are less than that of the femoral condylar distances. The medial tibial condyle is concave superiorly with radius of curvature of 80 mm. The lateral condyle convex superiorly with radius of curvature of 70 degrees. The shape of femoral surfaces is complimentary to that of tibial surface. The natural deflection outwards of the tibia on femur at the knee produces greater weight bearing stresses on the lateral femoral condyle than on the medial condyle, but because the medial condyle is prolonged further forward than lateral condyle, the vertical axis of rotation falls in a plane nearer to the medial condyle.

Joint contact

The mechanism of movement between femur and tibia is a combination of rolling and gliding. It changes throughout the range of knee flexion. During full extension of the knee the center of pressure is 25 mm anterior to the tibial plateau. The medial condyle of the femur rests 10 mm anterior to the lateral condyle. During 90 degree knee flexion the medial condyle rolls back 15 ± 2 and the lateral condyle 12 ± 2. Thus during flexion the femoral condyles moves posteriorly on the tibia.

Axis of rotation

The knee joint has features characteristic of both hinge and pivot joint articulation. The tibiofemoral joint has two degrees of freedom. The first one allows movement in sagittal plane, flexion and extension. The second degree of freedom is rotational movement along the long axis of tibia, which can be performed only when the knee is flexed. There is also an automatic axial rotation, thus during extension of knee the tibia externally rotates and during flexion it rotates internally. During rotatory movement the medial condyle have a smaller arc of motion than lateral condyle.

Screw home mechanism [(9)]

The articular surface of medial condyle is elongated anteriorly; hence when knee is extended the femur rotates internally until the medial condyle rests on articular surface. In the meantime lateral femoral condyle rotates in forward and lateral direction producing screw home movement to lock the knee in fully extended position.

REVIEW OF LITERATURE

HISTORICAL OVERVIEW [9] [1]

Distal femur fractures were treated conservatively in the past with casting, bracing and by skeletal traction. Before the 1960's conservative treatment was favored and they even documented better outcomes than operative treatment. But the trend was changed after the introduction of more refined techniques and implants by AO, the treatment recommendations began to change.

Stewart et al [10] in 1966, among 213 patients with distal femur fractures reported 67% of good to excellent outcome in 144 patients, treated with closed reduction and with ORIF only 54 % had good to excellent outcome among 69 patients.

Neer et all [11], in 1967, reported 90% satisfactory results with closed treatment and with ORIF only 52 % of patients had satisfactory outcome.

The surgical techniques and implants used in the above mentioned studies were not up to the present standards and the criteria for satisfactory outcomes are less acceptable.

Schatzker et al [12] in 1974 presented 75 % good to excellent results of 32 fractures treated with ORIF based on AO principles and only 32% good to excellent results in 39 fractures treated non operatively

In 1989, Siliski, Mahring and Hoffer reported good to excellent results in 81 % with 92% good to excellent results in type C1 fractures than 77% in type C2 or C3 fractures. They reported infection in 7.7%, shortening in 7.6% and malalignment in 5.8%.

The first prospective randomized study was published in 1996 by Butt et al in a series of patients with good to excellent results in 53% of patients treated surgically compared to 31% in non-operative group.

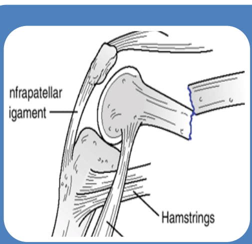
Balhofner et al [13], by using dynamic condylar screw by percutaneous technique reported good results in 84% among 57 patients with supracondylar fractures.

MECHANISM OF INJURY

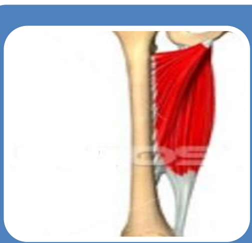
Most distal femur fractures are the result of severe axial loading with an associated varus, valgus, or rotational forces. In young patients this amount of force is mainly due to high velocity trauma such as motor vehicle accidents or fall from heights. But in elderly, trivial fall is sufficient enough to produce these types of injuries [(1)]. The anterior femoral cortex notching due to the chamfer cuts in total knee arthroplasty will predispose to these injuries [(14)].

The deformities occurring due to these fractures are primarily due to initial direction of fracture displacement and secondarily due to the direction of muscle pull.

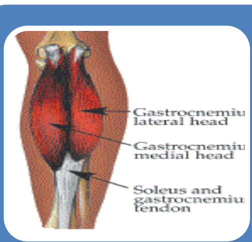
- The deformities occurring after trauma due to the forces exerted by quadriceps, hamstrings and gastrocnemius are
    a) Femoral shortening
    b) Apex posterior angulation
    c) Posterior displacement of the distal fragment
- The adductor pull causes varus deformity
- The rotational malalignment and splaying of condyles in intercondylar fractures are due to separate attachment of gastrocnemius heads to the femoral condyles.



Femoral shortening ,apex posterior angulation,Posterior displacement of the distal fragment due toquadriceps, hamstring & gastrocnemius



varus deformity due to adductor pull



Rotational malalignment of condyles due to seperate attachment of gastrocnemius heads to each condyles

Fig 9.Forces acting on distal femur

CLASSIFICATION

There are many classifications for distal femur fractures like AO/Muller, Neer's, Seinsheimer's but none of them are universally acceptable. These classifications mainly distinguish among extra articular, intra articular and isolated condylar involvement. These are further sub classified based on degree of comminution, degree and direction of displacement, and articular involvement. The classifications mainly based on anatomy and fail to address the other factors which determine the fracture management and functional outcome.

Factors influencing management and outcome

- Amount of fracture displacement
- Degree of comminution
- Soft tissue injury
- Neurovascular injuries
- Magnitude of joint involvement
- Degree of osteoporosis
- Associated multiple trauma
- Complex ipsilateral injuries

Most of the textbooks and articles prefer AO/Muller classification system which is simple to apply and most of the injuries fit into it. It also distinguish between extraaticular (Type A), partial articular (Type B), complete articular (Type C) and also accounts for fracture complexity.

Müller AO/OTA Classification Distal Femur Fractures [9]

33-An extra articular fracture

33-A1 simple

33-A2 metaphyseal wedge and/or fragmented wedge

33-A3 metaphyseal complex

33-B partial articular fracture

33-B1 lateral condyle, sagittal

33-B2 medial condyle, sagittal

33-B3 coronal split

33-C complete articular fracture

33-C1 articular simple, metaphyseal simple

33-C2 articular simple, metaphyseal multifragmentary

33-C3 articular multifragmentary

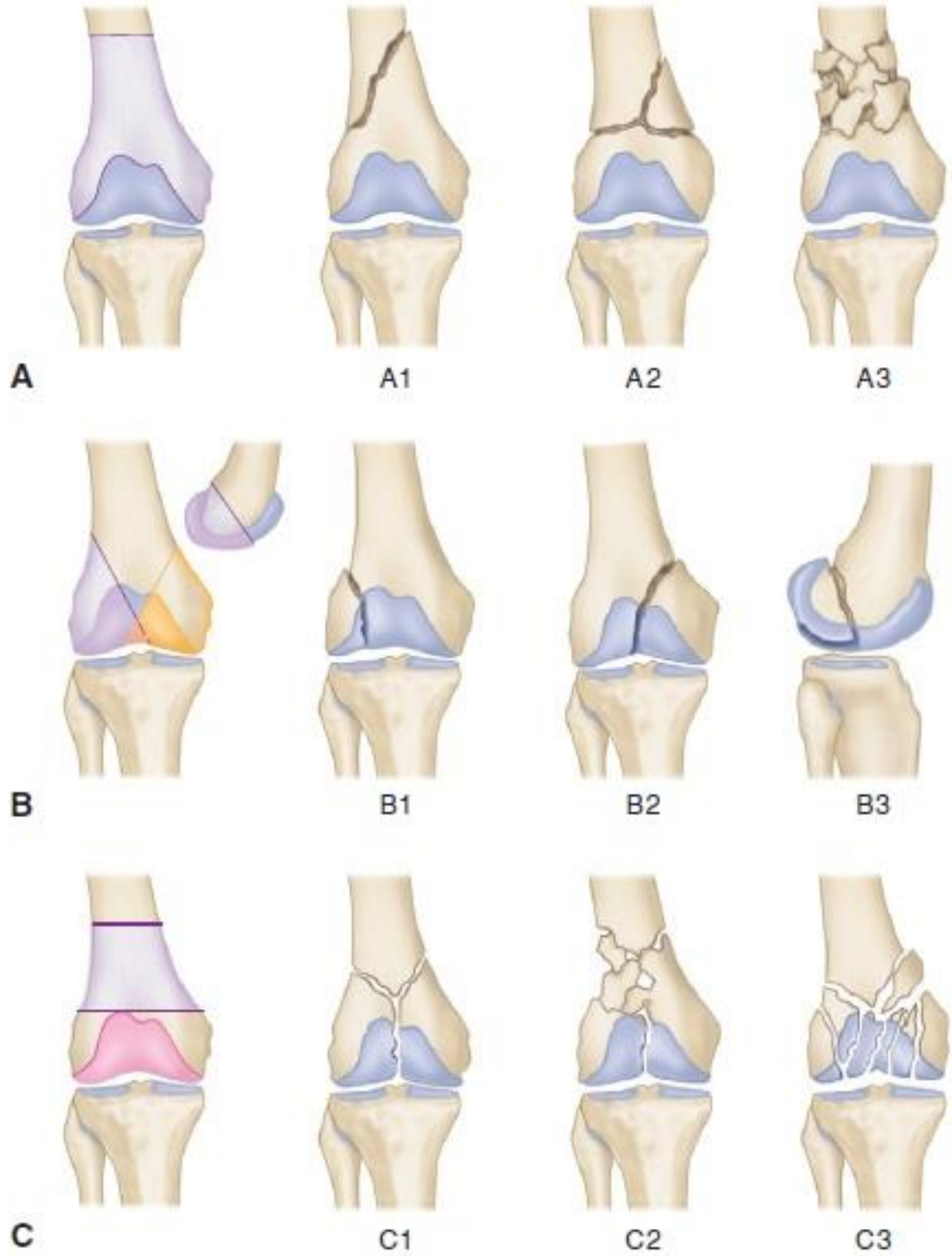


Fig 10.Classification of fractures distal femur by Muller et al

Neer's classification [11]

- I Minimal displacement
- IIA Medial displacement of condyles
- IIB Lateral displacement of condyles
- III Conjoined supracondylar and shaft

Stewart classification [10]

- Junction of middle and distal thirds
- Supracondylar
- Intercondylar
- Single condyle

Seinsheimer's classification [15]

- Type I – fracture with > 2 mm displacement.
- Type II – distal metaphyseal fracture without intercondylar extension.

  Type II A – two part fracture

  Type IIB – Comminution
- Type III – Condyle involvement with intercondylar extension

  Type IIIA – Medial condyle was separated

  Type IIIB – Lateral condyle was separated

Type III C – both condyle separated from each other and shaft.

- Type IV - Articular fractures that went outside of the intercondylar notch

  Type IVA – Medial

  Type IVB – Lateral

  Type IVC – comminuted, complex intercondylar injury.

ASSOCIATED INJURIES

The axial and bending load which produce the distal femur fractures also produce the fractures to the same extremity. Complete physical examination and radiological assessment is necessary to rule out the fractures of acetabulam, neck of femur and shaft of femur. Valgus or varus stress applied to the knee also produces ligamentous injury seen in up to 20% of cases. The same force may also produce tibial plateau or tibial shaft fractures.

5% to 10% of all supracondylar fractures are compound injuries. The open wound most commonly occurs in the anterior aspect of thigh proximal to the patella, and as a result some damage to the distal quadriceps muscle or tendon is frequent. [(1)]

Even though the femoral artery and popliteal artery are at the risk of injury due to its close proximity, injuries to these vessels are rare in supracondylar fractures. Injuries to these vessels are most common when these fractures are associated with knee dislocations.

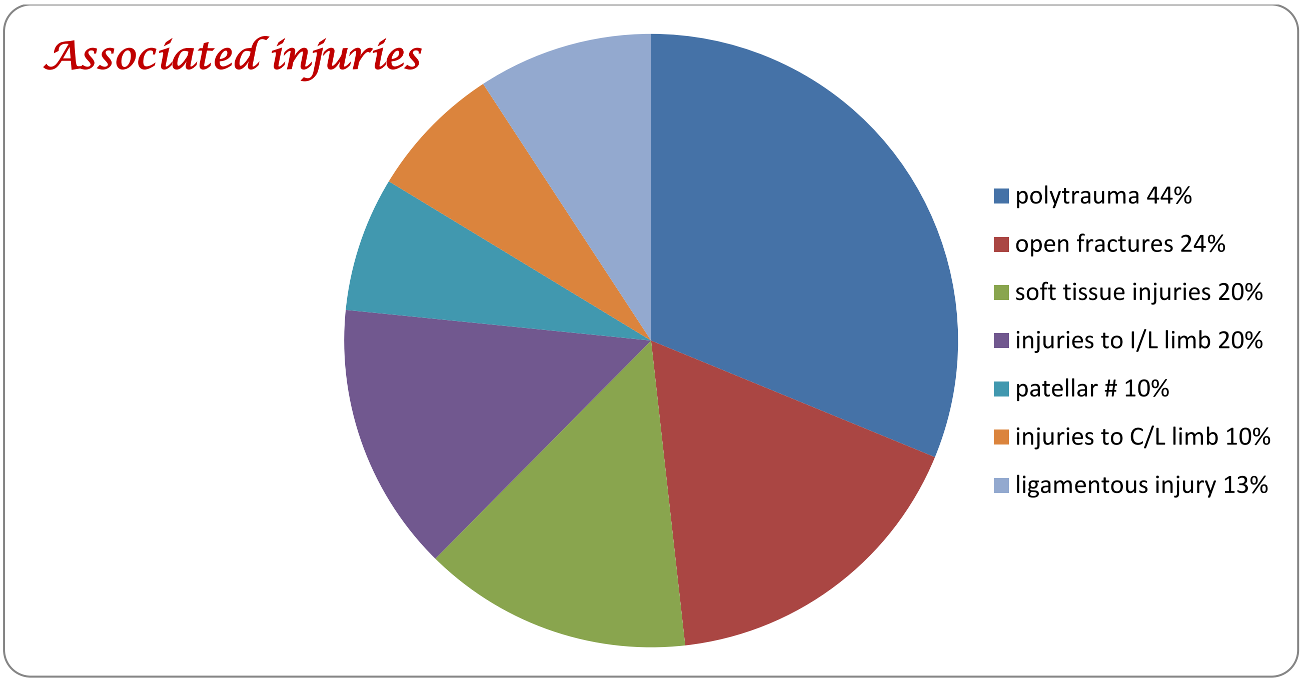


Fig 11.Associated injuries

SURGICAL APPROACHES TO DISTAL FEMUR [1] [6]

Several surgical approaches have been described and wise choice should be made depending on the fracture pattern, soft tissue injury, patient factors, implant selection, and surgeon expertise.

- Lateral approach
  a. Standard lateral technique
  b. Minimally invasive technique

- Medial approach

Standard lateral approach

This approach is most commonly used for the open reduction and internal fixation of distal femur fractures. Longitudinal skin incision is made centered over the lateral epicondyle and extending proximally as required. The fascia lata is incised in line with the skin incision. Vastus lateralis is reflected of the inter-muscular septum in anterior direction. Bleeding from perforators and lateral superior genicular artery should be ligated. Lateral condyle and shaft is exposed, wide soft tissue stripping should be avoided as far as possible.

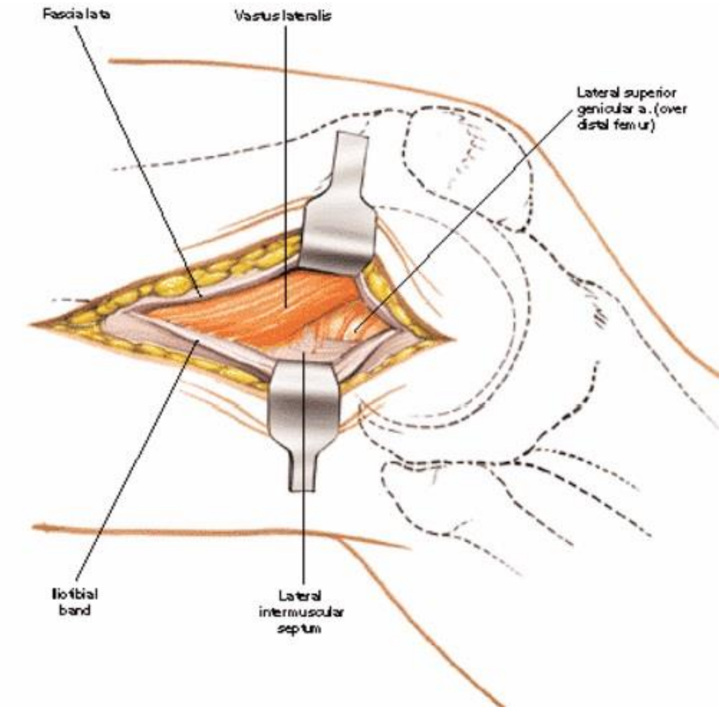


Fig 12.Standard lateral approch

Lateral – minimally invasive technique

A 5 – 6 cm limited incision placed over the lateral condyle large enough to insertion of the plate. Condylar screws are inserted through the same incision and proximal locking's made through separate stab incisions.

Medial approach

This approach is used for open reduction and internal fixation of type B2 and type B3 fractures. A straight incision made over the medial epicondyle and extending proximally into the distal thigh. Proximal extension should be made with utmost care, as the femoral vessels leaves the hunter's canal and enter the posterior compartment 10 – 12 cm above the knee joint. The medial retinaculum and joint capsule is incised and the medial condyle exposed. The dissection should be anterior to the medial collateral ligament to avoid injury to the medial meniscus.

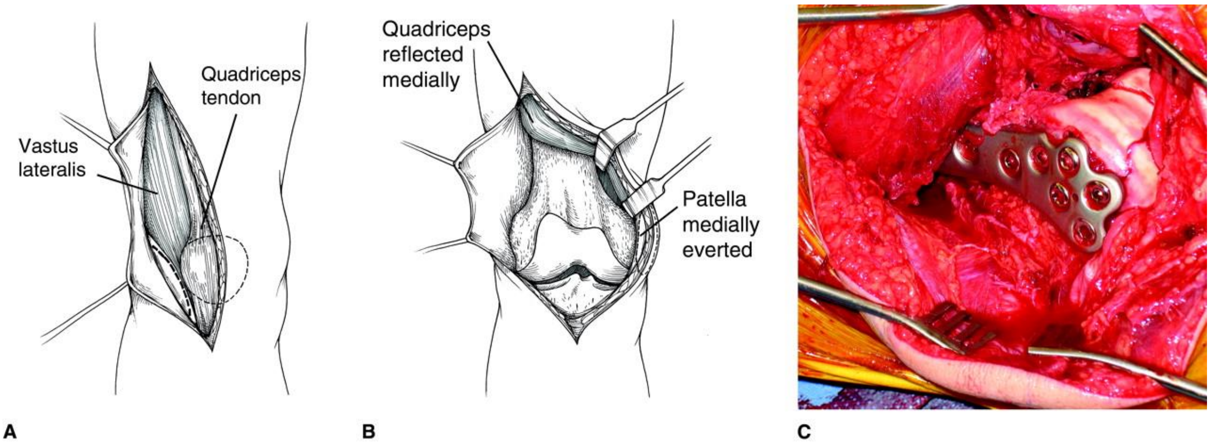
Lateral and medial Para patellar approach

These approaches are used for open reduction of intraarticular fractures. Lateral Para patellar approach is most commonly used, but if there is a major comminution in medial condyle medial approach is used. A longitudinal skin incision 1 cm lateral to the patella is made. Then a lateral or medial curvilinear retinacular incision is made and the knee joint is exposed. Lateral retinacular incision extended between vastus lateralis; rectus femoris and medial retinacular incision extended along the medial 1/3rd fibers of quadriceps. Eversion of patella and flexion of the knee gives access to the condylar surface, enabling reduction and fixation to reconstruct the articular surface.

Swashbuckler Approach (9)

A midline incision was made laterally from above the fracture to across the patella. The incision was extended directly down to the quadriceps fascia and it was incised in line with the skin incision and sharply dissected off the vastus lateralis muscle laterally to its inclusion with the iliotibial band. The iliotibial band and fascia was retracted laterally, and the dissection was continued down to the linea aspera. The lateral Para patellar retinaculum was incised, separating it from the vastus lateralis. A lateral Para patellar arthrotomy was made to expose the femoral condyles. A retractor was placed under the vastus lateralis and medialis which were retracted medially, exposing the distal femur and displacing the patella medially. The perforating vessels were ligated, and the vastus lateralis was elevated, exposing the entire distal femur.

Swashbuckler Approach



A B C

Fig 13.a.incision b. eversion of patella c. implant fixation

TREATMENT ALTERNATIVES

Non operative treatment

Conservative treatment is reserved for patients with undisplaced fractures and patients with significant medical comorbidities.

Indications for non-operative treatment [1]

Patient factors

- Non ambulatory patients(e.g. : paraplegia)
- Significant medical comorbidity

Fracture factors

- Undisplaced fractures
- Stable impacted fractures
- Unreconstructable fracture

Surgeon factor

- Lack of modern fixation devices
- Lack of experience in operative techniques

Non operative treatments of displaced distal femoral fractures are skeletal traction and cast bracing. This method is time consuming and leading to potentially severe complications including

- Deep vein thrombosis
- Pulmonary embolism
- Pressure sore
- Pneumonia
- Urinary retention and UTI

Stable fractures

Undisplaced, stable or impacted fractures are treated with casting or hinged knee bracing. Serial radiological monitoring is mandatory.

Unstable fractures

In displaced, unstable fractures 6 – 12 weeks of skeletal traction followed by Bracing. Upper tibial pin traction is applied and the limb is supported in Thomas Splint with a Pearson knee attachment or on a Bohler Braun splint. When fracture healing is evident, the traction can be converted into Neufeld type to avoid permanent knee stiffness [(16)].

Connolly and Mooney et al [(17)] described a more exacting technique of cast bracing with limb in extension, valgus and external rotation to avoid malunion.

Butt et al [(18)] compared conservative treatment versus dynamic condylar screw and reported three fold increased risk of DVT, pressure sores, UTI and pneumonia with conservative treatment.

OPERATIVE TREATMENT

Before the introduction **fixed angle construct** there was a marked difficulty to achieve and maintain stable fixation due to the following factors

- Fracture comminution
- Thin cortices
- Osteoporosis
- Wide medullary canal

With the availability of better implants, improved knowledge regarding soft tissue handling and advancements in anaesthetic measures made almost all patients treated with internal fixation.

Goals of internal fixation

- Anatomic reduction of articular surface
- Restoration of limb length and alignment
- Stable internal fixation
- Rapid mobilization
- Early rehabilitation

OSTEOSYNTHESIS WITH PLATES AND SCREWS [1] [19] [6]

Screws:

Screws are the major components in the treatment of distal femur fractures. Usually they are used in adjunct with other fixation devices. In specific situations like type B fractures in a young adult with adequate bone stock and without any comminution, it can be used alone for definitive fracture stabilization.

Screws can be used in two modes

- Interfragmental compression
- Buttress

In type B fractures after anatomical reduction transverse interfragmental screws perpendicular to the fracture line can be used to secure the reduction. The tendency to shear due to angular load can be countered by placement of buttress screw. This screw with a washer is placed in the intact bone above the apex of proximal fragment to prevent the proximal migration of the fractured fragment.

In complete articular fractures (Type C), transverse interfragmental compression screws can be used in a convergent fashion to accommodate subsequent placement of blade plate or condylar screw.

95- Degree blade plate

The 95- degree blade plate is based on the principle that anatomical alignment of knee in frontal plane is at 95^{o} to the lateral cortical contour of distal femur. Hence, during reconstruction the blade should be placed parallel to the femoral articular surface in order to achieve anatomical alignment. The blade should be inserted in correct orientation to avoid joint penetration and intercondylar notch impingement.

The center of blade insertion site is 1.5 to 2 cm above the distal articular surface and at the junction of anterior 1/3rd and posterior 2/3rd in the longest sagittal dimension of lateral condyle. Schatzker advised a position of blade as anterior as possible. [12]

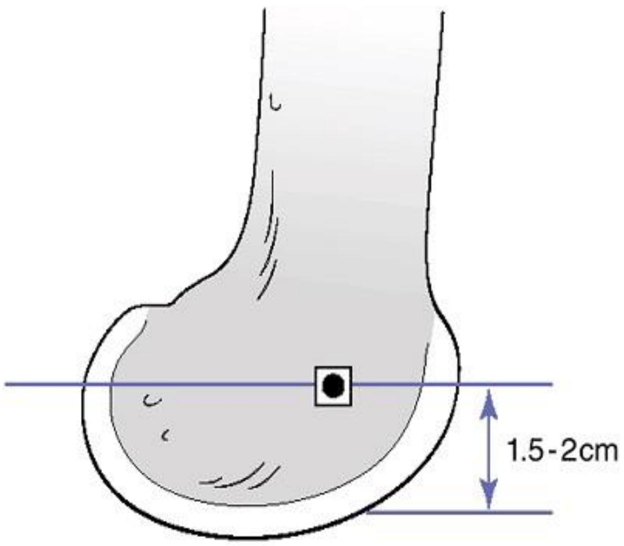


Fig 14.Blade insertion site in distal femur

To determine the trajectory of the blade three k-wires are placed under fluoroscopy guidance

- First k wire, along the distal femoral articular surface
- Second, over the anterior surface of distal femur
- Last one driven into the lateral femoral condyle, distal to the blade entry

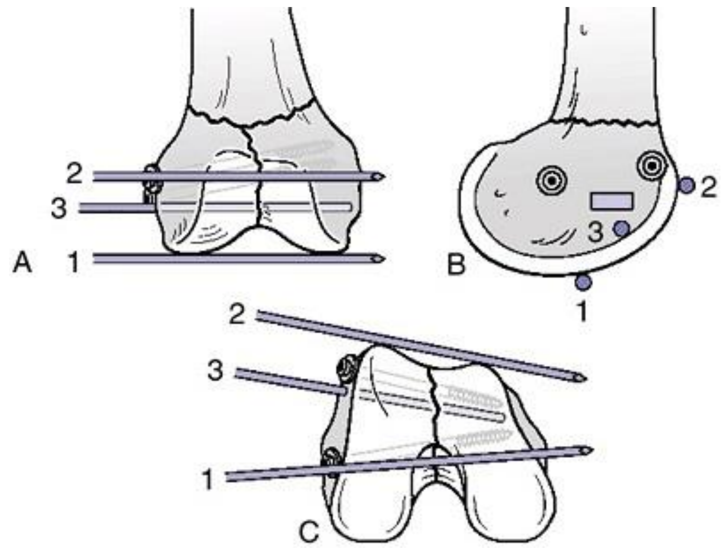


Fig 15.To determine the trajectory of the blade plate

The inserted blade cannot be changed readily and changes lead to loss of purchase and unstable fixation. When the blade is not parallel to the articular surface varus / valgus malalignment will occur. Posterior blade entry will lead to medialization of distal fragment and notch penetration. Flexion or extension deformity occurs due to malrotation of the blade.

Dynamic condylar screw

Dynamic condylar screw is a simplified fixed angle device (95^o). The advantage of this device is easier and more familiar insertion than blade plate. The lag screw has cannulated system; hence screw placement is easier once guide wire is properly positioned. Lag screw produces interfragmentary compression to the intercondylar elements. Flexion and extension can be adjusted even after the screw placement.

Disadvantages

- Lack of rotational control with the lag screw

- Bulkiness of the implant
- Amount of bone removed during insertion is greater than that of blade plate

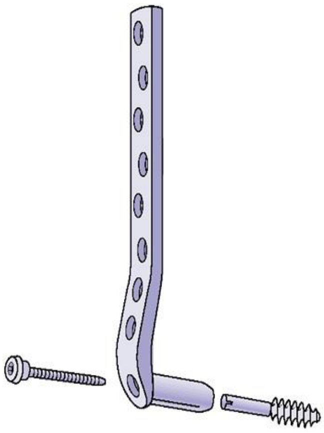


Fig 16.Dynamic condylar screw

The insertion point is similar to blade plate but slightly more proximal to articular surface and the insertion techniques are similar to that of blade plate by placing guide k-wires and under fluoroscopic guidance. The trapezoidal shape of distal femur should be in remembrance to avoid breaching of the medial cortex.

Non locking periarticular plates

In severely comminuted type C3 fractures the use of fixed angle devices leading to the disruption of articular fixation. In such cases anatomically precontoured non locking lateral distal femur plates are used. These are side specific, with multiple screw holes for multiple points of fixation of distal fragment which acts as a periarticular buttress plate.

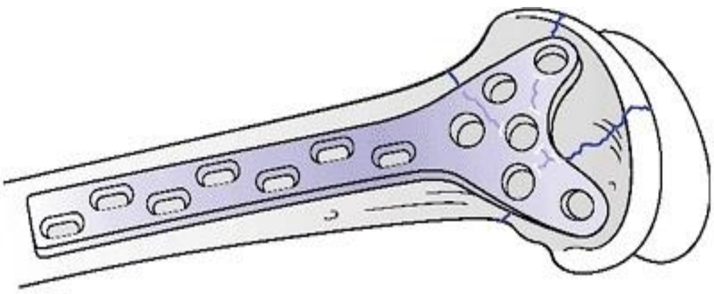


Fig 17.Condylar buttress plate

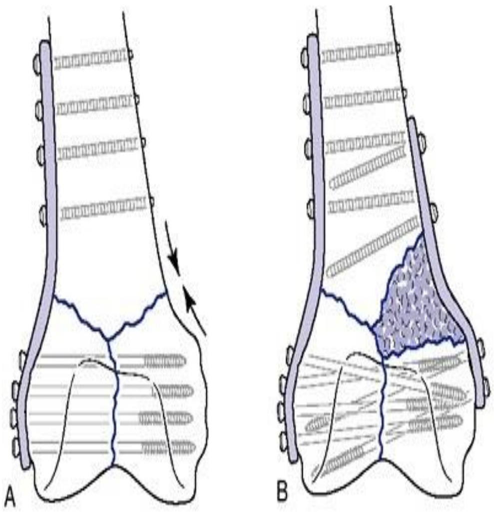


Fig 18 a.With intact medial bony column b. with medial cortical defect

These plates do not have any inherent varus or valgus stability. With a well reconstructed medial column condylar buttress plate alone is suffice. In case of medial cortical defect it should be stabilized with additional fixation like medial buttress plate and bone grafting. With the introduction of locking plates these plates become obsolete.

Intramedullary nails

The use of intramedullary nails offer some advantage over traditional plating

- Being an intramedullary device , these are load sharing devices.
- Causes less soft tissue trauma during application.
- Inserted rapidly thus decreases operating time and blood loss.

Locked retrograde femoral nailing

Modern retrograde nailing system allows multiple distal locking screws in several planes to augment the stability of condylar block. The nail length varies from short to long, longer nail crossing the isthmus is better to prevent windshield – wipering effect. (20) Ante grade femoral nail can also be used but, retrograde nailing provides better stability and maintaining alignment of distal femur fractures. (21)

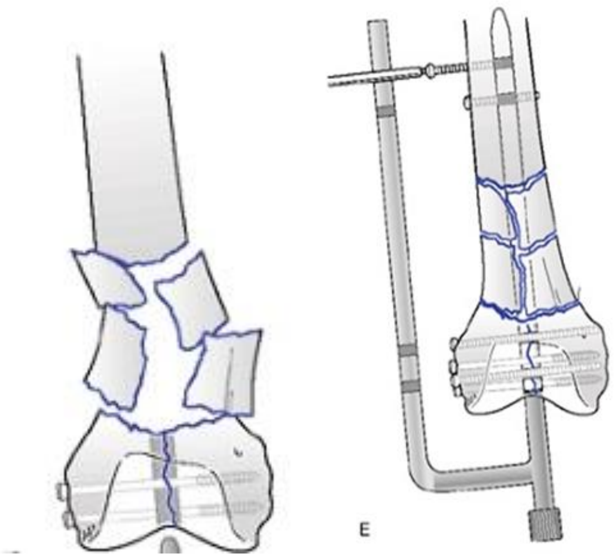


Fig 19.Locked retrograde femoral nailing

Disadvantages (22)

- Knee stiffness
- Sepsis
- Patellofemoral pain

- Synovial metallosis
- Patello femoral joint destruction - due to inadvertent reaming of patella

Comminuted C3 fractures are difficult to stabilize with a nail due to relatively few points of fixation.

External fixator

External fixator is used infrequently as a definitive treatment for distal femur fractures. Most commonly it is used for temporary stabilization as a part of Damage control orthopaedics in case of, severely injured patient or if there is any anticipatory delay in surgery for more than 36 hours.

Major indications for definitive external fixator

- Active infection resistant to aggressive treatment
- Severe open injuries (type III B)

Advantages of temporary external fixator [23]

- Rapid application
- Minimal soft tissue dissection
- Maintaining length and alignment
- Early mobilization

Once the patient and soft tissue improves definitive fixation should be done. The pin placement should avoid the areas of planned surgical incisions.

Ilizarov fixator [24]

Ring fixator can be used in severely comminuted and compound fractures of the distal femur. **Arazi et al**, in his study among 14 patients; reported good to excellent outcome in 64% of patients.

Advantages

- Greater stability
- minimal blood loss
- no periosteal stripping
- rapid healing of the fracture
- minimal surgical exposure

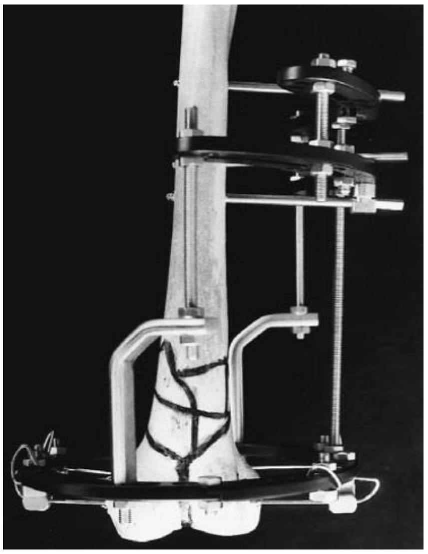


Fig 20.Ilizarov fixation for type C2 fracture

LOCKING COMPRESSION PLATES

Evolution of lcp [19]

The zespol system, developed in 1970's functioned as a first internal fixator for stabilizing long bone fractures. A similar device called "schuhli" was designed by Jeffrey mast. Schuhli consists of standard plate and screws, but the screws are locked to the plate using a washer at the plate bone interface. Point contact fixator (PC-Fix) was developed by AO, which has minimal contact with the bone and secured by unicortical screws which preserves the periosteal and endosteal blood supply and results in rapid bone healing. The tapered head of the screw lodges firmly in the plate and provides angular stability. This leads to the development of less invasive skeletal stabilization (LISS) and locking compression plate (LCP).

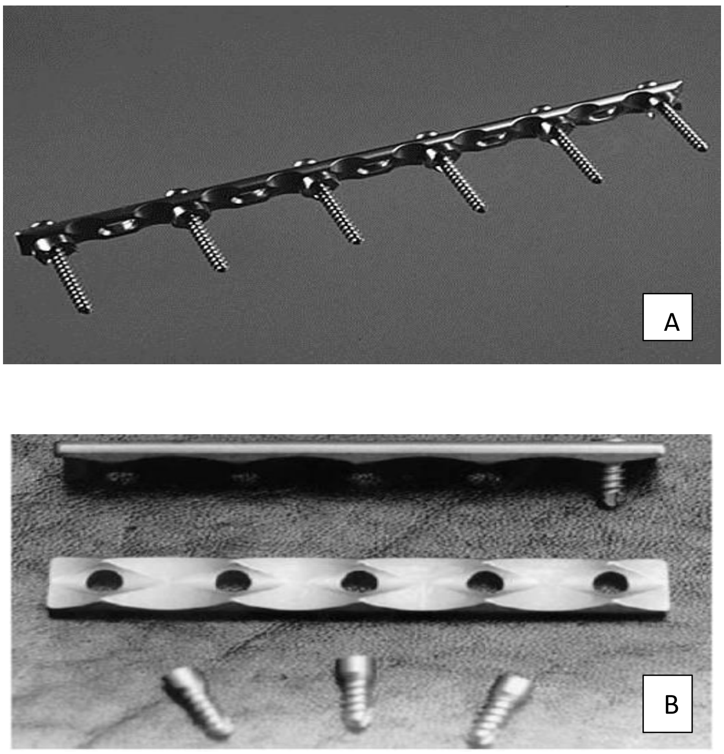


Fig 21 A. Schuhli plate B. Point contact fixator

Locking head screws [25]

Axial stability was not achieved by tapered screw- plate connection of the PC-fix screws alone, point contact of the plate with the bone is still necessary to achieve stability. This leads to the development of locking head screws, providing both angular and axial stability without any plate – bone contact. Non-contact plates with angular stability are called locked internal fixators. In conventional cortical or cancellous screws, axial preloading will prevents the micro movements leading to screw loosening. Locking head screws are not tightened in the bone but in the plate, allows micro motion within the fracture fragments. The locking head screws subjected mainly to the bending and shearing forces occurring at the neck of the screw. To overcome this, locking screws have 0.5 mm larger outer diameter and 1.3 mm larger core diameter than the conventional screws. By this the locking screws can withstand 100% more shearing and 200% more bending stresses.

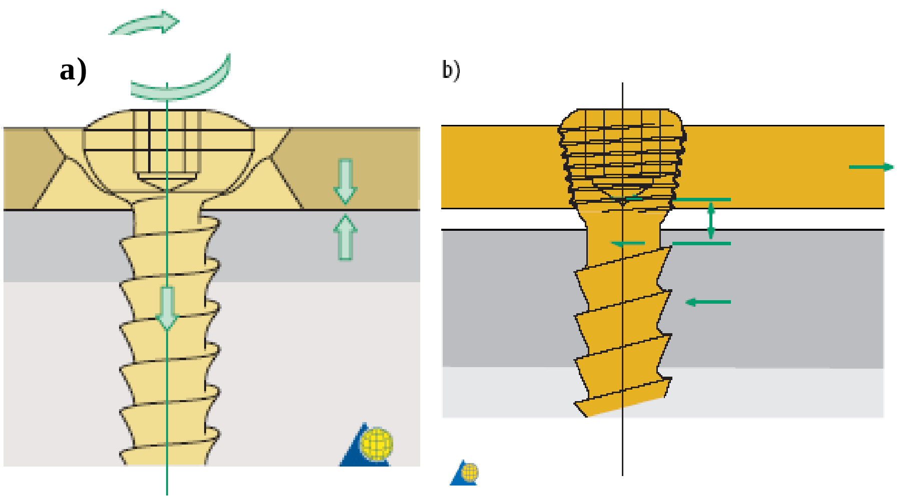


Fig 22.Forces acting in the a.conventional plate using standard

Screws and in b.locking head screws

Less invasive skeletal stabilization (LISS)

LISS is a non-contact, locked internal fixator inserted percutaneously and self-drilling, self-tapping, monocortical locking head screws are used. The screws are inserted through stab incision with the help of radiolucent aiming device. A closed, indirect reduction with pure splinting at the fracture site is most important in LISS plating.

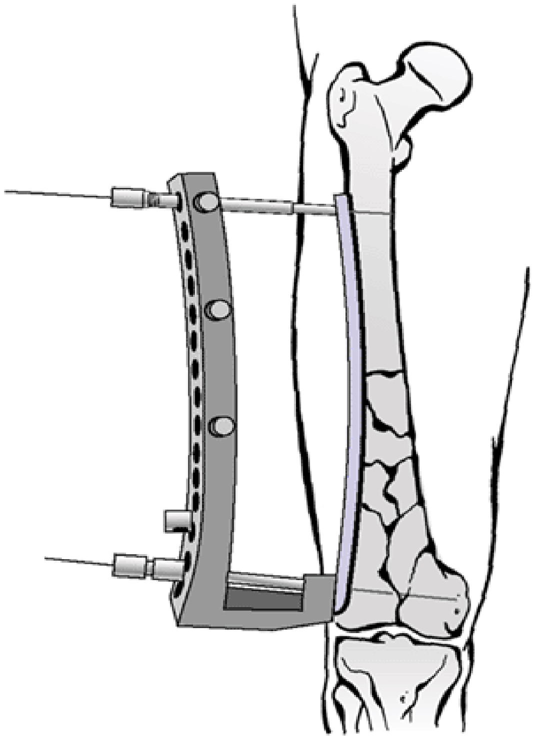


Fig 23.Less invasive skeletal stabilization (LISS)

Locking compression plate

LISS plating would only accommodate locking head screws and many surgeons found it too restrictive. This leads to the development of locking compression plates with combination hole which allows greater flexibility in the use of screws. This can accommodate conventional screws, locking screws or both. This allows the surgeon to decide intraoperatively whether to achieve relative stability using locking head screws or absolute stability using conventional screws. The distal femur locking compression plate is similar to LISS DF, but has an added advantage of accommodating cortical screws which can aid in some indirect reduction by pulling the bone towards the anatomically pre contoured plate.

Fig 24.Locking compression plate – Distal femur

Fig 25.LCP-DF combi holes

Advantages of Locking Head Screws

1) Provide better anchorage both in elastic bridging fixation and in absolutely stable fixation
2) Blood supply to the periosteum and medullary cavity is preserved.
3) No structural bone loss in the opposite cortex.
4) Easier to apply monocortical screws in blind minimally invasive percutaneous osteosysthesis.
5) Bicortical cortical screws offer improved stability in epiphyseal and metaphyseal regions of the bone.
6) They provide fixed angle device, preventing varus collapse, toggle and sequential screw loosening particularly in osteoporotic bone. [26]

Disadvantages [19]

1) The surgeon has no tactile feedback as to the quality of bone, when tightening the screws because the screws stop abruptly when threads are completely seated into the plate regardless of bone quality.
2) Locked screws on its own will not pull the plate down to bone; hence this lack of construct reduction capability, combined with percutaneous plating techniques, can result in higher rates of fracture malalignment than that occur with formal open reduction and internal fixation.
3) Another concern is the rigidity of a locked screw plate construct. Any fracture distraction at the time of reduction or fracture resorption during healing will be

held rigidly by such constructs which prevent bone to bone contact and may potentially result in delayed union or non-union.

4) No load sharing can occur with locked screws on either side of a fracture. If the fracture is repetitively loaded, the plate eventually may fracture or fixation may be lost.

5) Contouring locked plates distort the screw holes and adversely affect the screw purchase.

6) Hardware removal may be more difficult, if locked screw become cold welded to the plate.

MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS

History & Evolution of MIPO: [19]

In 1965, AO emphasized perfect anatomical reduction & rigid internal fixation of fractures. However, they found rigid internal fixation did not always produce the desired end result. The instances of following complications were observed.

- Sepsis
- Sequestrum formation
- Temporary porosis at the plate footprint
- Refractures
- Delayed & Non union

This lead to the development of Biological internal fixation and the concept of fracture fixation shifts from **absolute stability to relative stability.**

Inter fragmentary strain:

Fractures with a single ,narrow gap are very intolerant to even minute amount of displacement, while multi fragmentary fractures can tolerate greater amount of displacement as the overall displacement is shared between many fracture gaps.

It became apparent that anatomical reduction and rigid internal fixation were not absolutely needed to achieve union in multi fragmentary fractures. This leads to the concept of minimally invasive plate osteosynthesis (MIPO). The main aim in multi fragmentary fractures is to regain length, alignment and rotation by indirect reduction techniques.

Indirect reduction techniques. (27)

- Placing pads or bolster beneath the knee to keep it in 60 degrees flexion
- Fracture table
- Reduction by implant
- Femoral distractor
- Reduction handles
- External fixators
- Collinear reduction clamps

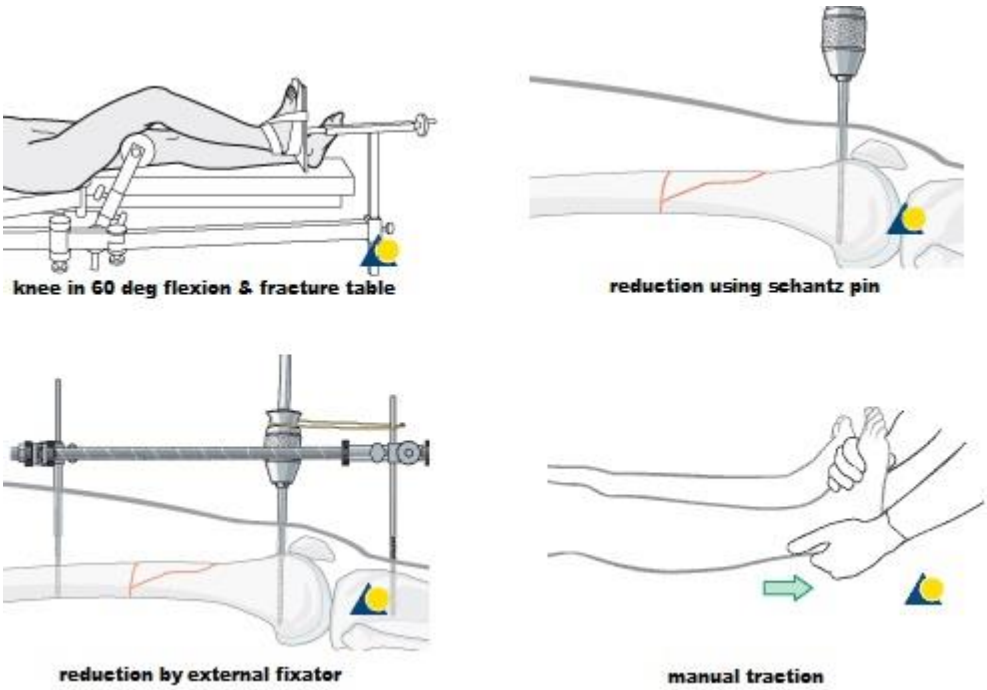


Fig 26. Indirect reduction techniques

Advantages of MIPO: [19]

- By providing relative stability, allows micro motion at the fracture site resulting in rapid and reliable bone healing.
- Both periosteal and endosteal blood supply is preserved.
- Avoids the need of precise reduction, especially of the intermediate fragments. Hence fracture hematoma is not disturbed
- **Bone grafting** not required
- Decreased cortical necrosis and stress shielding.
- Provide **both angular and axial stability**
- Improved local resistance to infection
- Less post-operative pain and faster rehabilitation due to less soft tissue damage

Disadvantages:

- The stability of fracture fixation depends on the rigidity of the construct.
- Malunion
- Closed reduction & intraoperative control of alignment is difficult.
- Due to predetermined screw orientation, there is a risk of articular penetration in anatomically non contoured LCP.
- Increased radiation exposure.
- Excessive demands of the system.

COMPLICATIONS

Although the use of biologic principles and LCP by MIPO technique has improved results, it does not always warranty a favourable outcome. The following complications are described in the literature.

Early complications:

Infection:

Infection following MIPO technique is not common but if occurs, early diagnosis and treatment are essential. In sub muscular techniques the pain & fever appears late. Elevated ESR, C- reactive protein, and leucocyte count often lead to the diagnosis. In case of doubt early wound exploration with irrigation and debridement are indicated along with i.v antibiotics.

Deep vein thrombosis: [18]

Venous thromboembolism constitutes an important cause of early post-operative morbidity and mortality. The important risk factors include

- Advanced age
- Obesity
- History of DVT
- Prolonged immobilization
- Pregnancy
- Oestrogen use
- Multiple trauma

DVT prophylaxis in high risk group and early mobilization lowers the risk of fatal pulmonary embolism.

Late complications:

Knee stiffness:

It is the most common complication after distal femur fractures. Quadriceps scarring with or without arthro fibrosis of the knee and patella femoral joint often leads to loss of knee motion. Post operatively patients should regain 90 degrees of motion in 4 weeks. Stable fixation, meticulous soft tissue handling with early rehabilitation will result in optimal regain of knee movements. Persistent stiffness beyond 8-10 weeks is worrisome; some young patients may require manipulation or arthroscopic lysis to release the adhesions.

Malalignment / Malunion: [28]

Malalignment greater than 5-10 degrees is likely to affect the knee biomechanics and hence the gait. Increased varus/valgus angulation leads to overloading of joint and later arthritis. Fixation failure and varus collapse commonly occurs with traditional plating and uncommonly seen in locking plates due to its angular stability.

Malrotation:

In the distal femur deforming forces causing malrotation are less and therefore it is less common. Rotational deformity more than 15° is unacceptable, should be corrected.

Non-union:

After the advent of biologic principles in fracture fixation and improved implants the incidence of non-union is rare. Schutz et al reported 93 % union [29] and Kregor et al reported 95% union rates using LISS [30]. Kim et al reported 95 % union rates with LCP DF by MIPO technique. [31]

Implant failure

In contrast to the conventional techniques screw breakage is more common than plate breakage in MIPO. The locking head screws subjected mainly to the bending and shearing forces occurring at the neck of the screw. Understanding of strain theory and using adequate plate- span ratio may overcome this problem.

Hardware problems:

Locking plates can cause pain due to irritation at two sites.

- Ilio tibial band rubs the plate and causes pain during AP motion of the knee joint.
- Condylar screws penetrating the medial cortex and irritating the medial soft tissues.

MATERIALS AND METHODS

Study topic : A short term analysis of the functional and radiological outcome Of distal femoral fractures fixed with locking compression plate by minimally invasive plate osteosynthesis (MIPO) technique.

Study Design : Prospective study

Study Venue : Department of Orthopaedics,
Kilpauk Medical College and Hospital,
Kilpauk, Chennai – 600010.

Period of Study : JULY 2011 to November 2013

Sample size : Twenty patients

Data collection : Collection of data as per proforma with written & informed consent from the patients admitted in Orthopaedic ward, Kilpauk Medical College hospital.

Inclusion criteria [6]

- Patients in the age group of above 18 years
- Distal femoral fractures – Müllers type A ,C1 and C2
- < 2 weeks of injury
- Fractures reducible by indirect methods
- Grade I and II compound injuries (Gustillo Anderson)

Exclusion criteria [6]

- Fractures with grade III compound injuries
- Active infection
- Muller type B & C3 fractures
- Skeletal immaturity
- > 2 weeks of injury (fracture may not reducible by indirect methods)
- Periprosthetic fractures
- Comatosed patients
- Patients with risk of infections like on immune suppressants drugs
- Pathological fractures

Pre-operative assessment:

After initial resuscitation a meticulous history was taken and thorough clinical examination was done to rule out other associated injuries. Distal vascularity and neurological status should be assessed. Any open injury should be addressed vigorously with thorough wound debridement and stay sutures applied . Informed and written consent for the surgery and willingness to participate in the study are obtained from all the patients.

Investigations:

Radiographs of affected femur with knee in AP & Lateral projections were taken along with the pelvis x- ray with hips, proximal femur and x – rays of other affected extremity. The fracture was then classified based on AO Muller classification. Initially the limb was immobilized with a high above knee slab or skeletal traction. Routine investigations like complete haemogram, Blood sugar, Urea, Creatinine, Serum electrolytes, X- ray Chest , ECG, BT, CT was done. Medical and anaesthetic fitness was obtained for all the patients before surgery.

Implant selection

The preoperative x-ray is used to determine the length of the distal femur LCP and the position of the screws. To measure the length of the condylar screw, the Maximum condylar width on the radiograph is determined to determine the real condylar width. The two important values are used in determining the length of the plate.

Plate span ratio: [6]

The plate span ratio is the quotient of the plate length to the overall fracture length. Empirically the plate span ratio should be

- 2-3 times in multi fragmentary fractures
- 8-10 times in simple fractures

Plate – screw density:

It is the quotient formed by the number of screws inserted to the number of screw holes in the plate. Ideally, the density should below 0.5 -0.4 which means, only less than half of plate holes should be occupied by the screws.

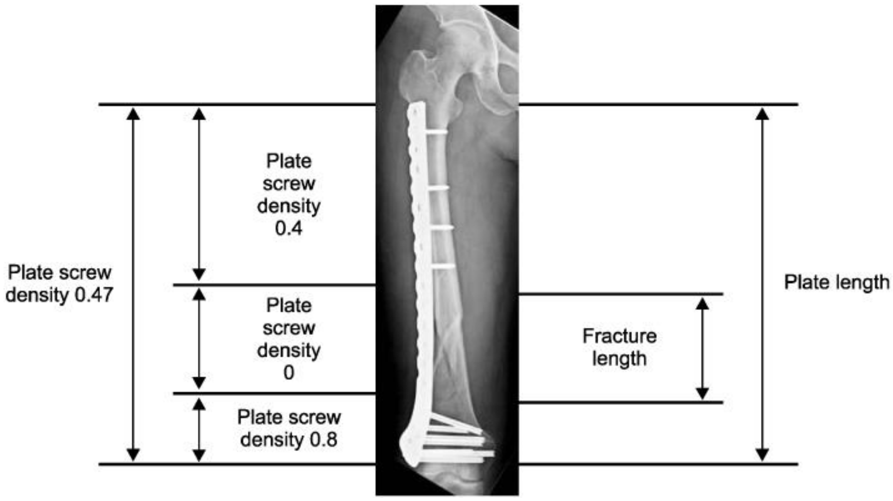


Fig 27. Plate screw ratio & density

Fig 28.Implants used

A – LCP-DF
B – 4mm drill bit
C – 6.5mm drill sleeve
D – 5mm drill sleeve
J – screw driver

F – 6.5mm 32mm threaded cancellous LHS
G – 6.5mm 16mm threaded cancellous LHS
H – 5mm fully threaded cancellous LHS
E – 6.5mm fully threaded cancellous LHS
I – 5mm LHS

Surgery:

Anaesthesia:

All the patients are operated under spinal, epidural or combined spinal- epidural anaesthesia. Spinal anaesthesia was generally used. Combined spinal – epidural anaesthesia was chosen in case of anticipatory increase in duration of surgery due to difficulty in fracture reduction.

Prophylactic antibiotics:

Gram positive prophylactic antibiotic in case of closed fractures, adding a gram negative prophylactic cover in open fractures. Antibiotics were given one hour prior to surgery. The most important thing is that, antibiotic therapy will never compensate for poor surgical techniques.

Patient positioning:

The patient positioned supine on a radiolucent operating table with a bolster or a sterile sand bag beneath the knee of the injured extremity in 60-70 degrees of flexion. The patella should face anteriorly and in neutral. Sterile scrubbing and draping should allow adequate exposure and free movements of the knee and thigh. The image intensifier is positioned on the side opposite to the injured limb.

Fig 29.patient positioning

Surgical approach:

The approach used depends upon the presence articular extension.

- Modified standard lateral approach – Extra articular fractures
- Lateral / medial Para patellar approach – Intra articular fractures

In this study modified standard lateral approach was used in all of the cases because, Type C3 fractures which requires open reduction of condyles are excluded from this study and the cases of Type C1 & C2 in this study are with simple, articular extensions which does not require any open reduction.

Modified standard lateral approach: [6]

The skin is incised from Gerdy's tubercle and extending proximally for about 6-8 cm. The Iliotibial band is cut along the direction of its fibres. The space is created in the epiperiosteal plane between the vastus lateralis and the periosteum thus creating a sub muscular tunnel. A similar incision is made that corresponding to the proximal end of the plate is made and the lateral femoral cortex is exposed .The joint capsule may be opened if required, along in line with the ilio tibial band. The opening of joint capsule is not necessary in extra articular fractures; it offers an advantage of correct seating of implant over the lateral femoral condyle under direct visualization.

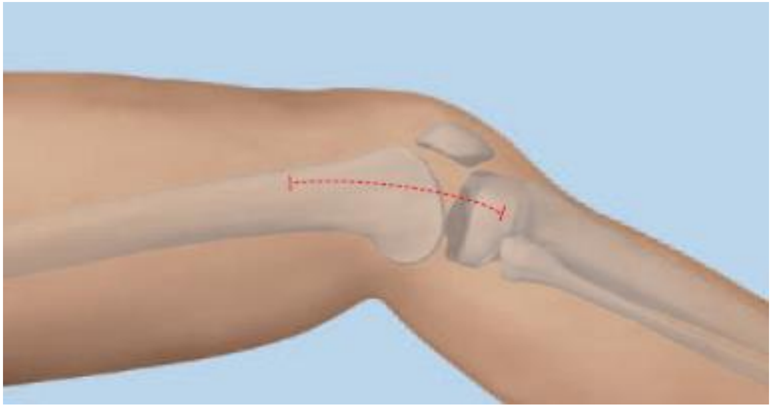


Fig 30.Landmark for skin incision

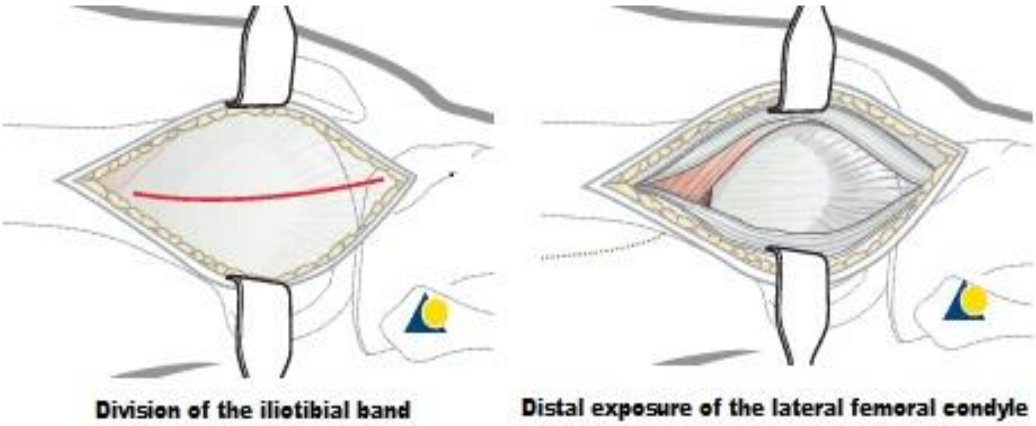


Fig 31.Surgical exposure

Technique:

Then the plate is inserted into the sub muscular tunnel and the distal end seated over the anterior 2/3rd of the lateral femoral condyle and fixed with temporary k-wire. The plate usually lays 1.0-1.5 cm posterior to the most anterior aspect of distal femoral condyle and 1.0-1.5 cm cranial to the articular surface. The proximal end of plate is visualised in the proximal incision and the central position of the plate in the lateral shaft of femur is ensured. Then the fracture is reduced under fluoroscopic guidance by indirect reduction techniques.

The indirect reduction techniques includes

- Placing a bolster or pads behind the knee to attain 60 degrees of knee flexion
- Manual traction applied to the ankle with a force vector directed posteriorly using the posterior pad acting as a fulcrum. This manoeuvre will help to reduce the fracture and restore the limb length, rotation and alignment.
- The schanz screw inserted in antero posterior direction can be used as a joystick to derotate and align the fragment into proper alignment.
- The anatomically pre shaped plate aid in some amount of indirect reduction by bringing the bone towards the plate with the use of standard cortical screws.

Fig 32.Temporary k- wire fixation

Definitive fixation:

The reduction is assessed with the image intensifier for quality of reduction, length, rotation and alignment. The condyles were fixed to the plate using 6.5mm cannulated locking head cancellous screws. Then the proximal end of plate is fixed to the proximal fragment using 5.0 mm locking head screw. The other proximal screws are inserted using multiple stab incisions and fluoroscopic control. During the entire procedure the reduction and the position of the plate were controlled clinically and often checked with image intensifier to avoid any loss of reduction or implant malpositioning. Conventional cortical screw was not used in any of our cases.

Fig 33.Intra operative picture

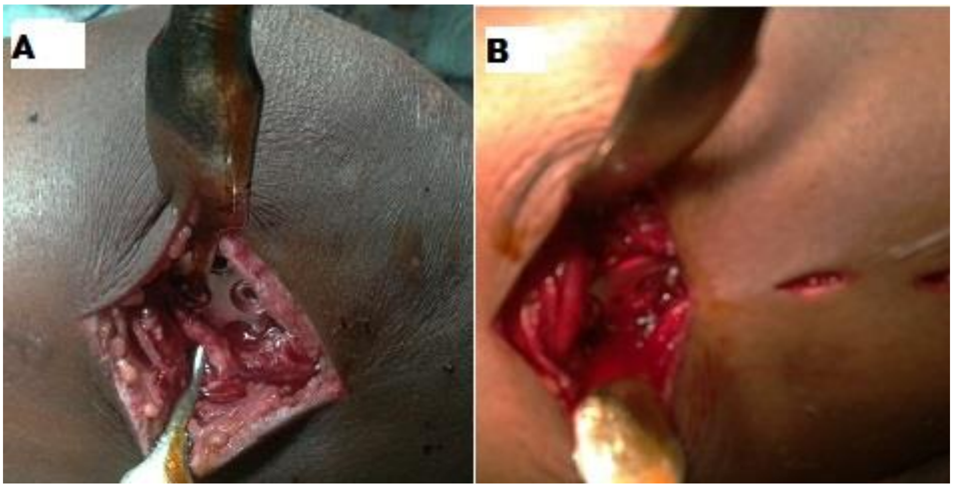


Fig 34 A.Distal fixation B. proximal fixation

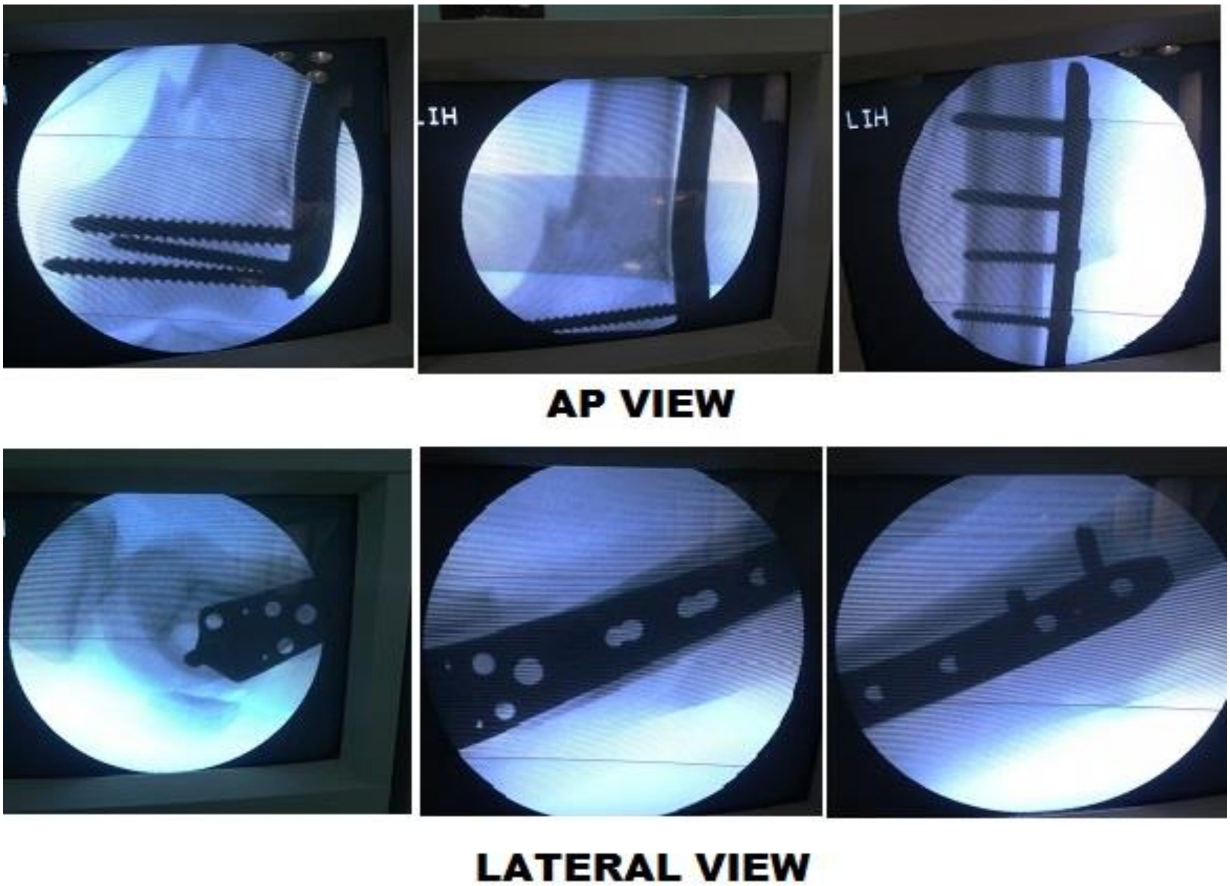


Fig 35.Intra operative imaging

Wound closure:

After thorough wound wash fascia of the vastus lateralis and the iliotibial band are closed with 1 vicryl. The subcutaneous tissue was closed with 1-0 vicryl and skin sutured with 2-0 ethilon. The suction drain was used in all the cases.

Post-operative period:

Post-operative i.v antibiotics to cover both gram positive and gram negative spectrum were given for 5- 7 days. Adequate analgesia in the form of epidural / intravenous/ intramuscular were administered to reduce the pain and to improve patient comfort. This would encourage the patient to cooperate effectively in post-operative rehabilitation program. DVT prophylaxis started in high risk patients like patients with previous history, obesity, prolonged bed rest, polytrauma and oestrogen use.

Wound care & drain:

Drains were removed within 48 hours of surgery. Wound was kept clean & dry. Soaked dressing changed. Sutures removed after 12-14 post-operative day.

Mobilization & weight bearing:

Mobilization was started as soon as possible even from the first post-operative day. Joints should be mobilized by active or active assisted movements. Non weight bearing ambulation was started as soon as possible and gradually partial weight bearing (10-15 kg) started within 2 weeks of surgery. In case of articular fractures continuous passive motion may be helpful in restoring joint motion. Full weight bearing is allowed after radiological evidence of healing.

GOALS OF REHABILITATION [19]

- About 65° - 70° flexion is required during the swing phase of normal gait.
- About 90° flexion is required to ascend and descend stairs.
- About 105º flexion is required to rise early from a low chair and to tie one’s shoes.
- To achieve this, CPM was recommended for 3 hours daily for 2-3 weeks, till the patient achieves more than 100º flexion.

Post-operative X-Ray examination:

X-rays are taken in the immediate post-operative period to document the fracture reduction and fixation. Implant should be well seated on the lateral cortex without any sagittal deviation. X-rays of femur with knee in AP & lateral views are taken. There after x- rays are repeated at every 4- 6 weeks interval to monitor the fracture union and to detect any implant loosening or failure.

Follow up:

The patient was discharged when the post-operative x-rays are satisfactory and there was no signs and symptoms of infection. The patients were advised to come for regular follow up at 4-6 weeks interval and x-rays are taken during that time. The following parameters are documented during the follow up period.

1. Implant position, any evidence of loosening or breakage.
2. Fracture union both clinical and radiological and its progression fracture healing from radiographs according to Hammer et al [32]
3. Length, alignment and rotation.
4. Knee flexion
5. Outcome is measured using American knee society scoring system [33] [34]

Alignment:

The post-operative alignment is measured clinically using a goniometer.

Rotation: [6]

Post-operative rotation is measured clinically using Hip rotation test.

Hip rotation test: The rotation of femur can be checked and compared with opposite limb with both hip and knee flexed to 90 degrees.

Criteria for clinical fracture union:

1. No pain/ tenderness on weight bearing
2. No pain/ tenderness on palpation / examination
3. Ability to walk /perform activities of daily living with no pain.

Criteria for radiological union: [32]

Radiological assessment of fracture healing ***Hammer et al***			
Grade	Callus Formation	Fracture line	Stage of union
1	Homogeneous bone structure	Obliterated	Achieved
2	Massive .Bone trabeculae crossing fracture line	Barely discernible	Achieved
3	Apparent. Bridging of fracture line	Discernible	Uncertain
4	Trace. No bridging of fracture line	Distinct	Not achieved
5	No callus formation	Distinct	Not achieved

Knee society score: [34]

The outcome analysis done using American knee society scoring system. The total score is 200 comprises of

- knee score – 100
- function score – 100

Outcome	Knee score (100)	Function score(100)	Total score (200)
Excellent	80-100	80-100	160-200
Good	70-79	70-79	140-159
Fair	60-69	60-69	120-139
Poor	< 60	< 60	< 120

OBSERVATION AND RESULTS

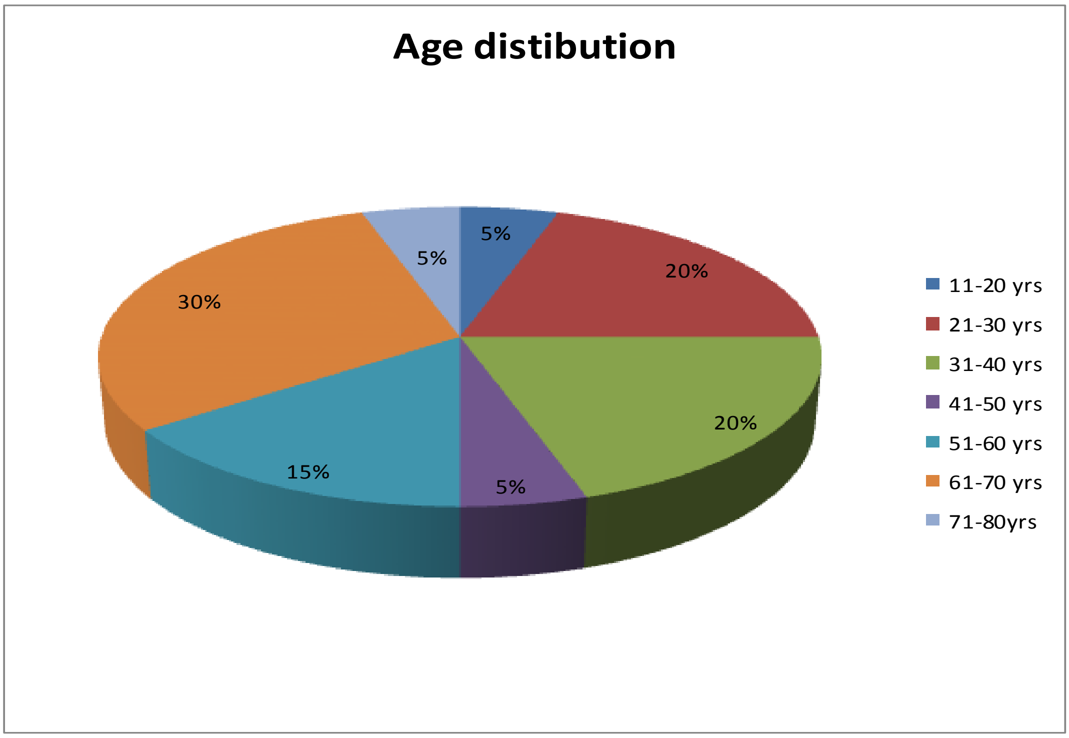
The results were analysed prospectively both clinically and radiologically. The follow up period ranged from 6 months to 18 months (mean = 12 month)

Table I – AGE DISTRIBUTION

s. no	Age (in years)	No. of patients	Percentage
1	11-20	1	5
2	21-30	4	20
3	31-40	4	20
4	41-50	1	5
5	51-60	3	15
6	61-70	6	30
7	71-80	1	5

Table II – SEX DISTRIBUTION

S. no	Sex	No. of patients	Percentage
1	Male	13	65
2	Female	7	35


Age distibution
5%
5%
20%
30%
20%
15%
5%
11-20 yrs
21-30 yrs
31-40 yrs
41-50 yrs
51-60 yrs
61-70 yrs
71-80yrs

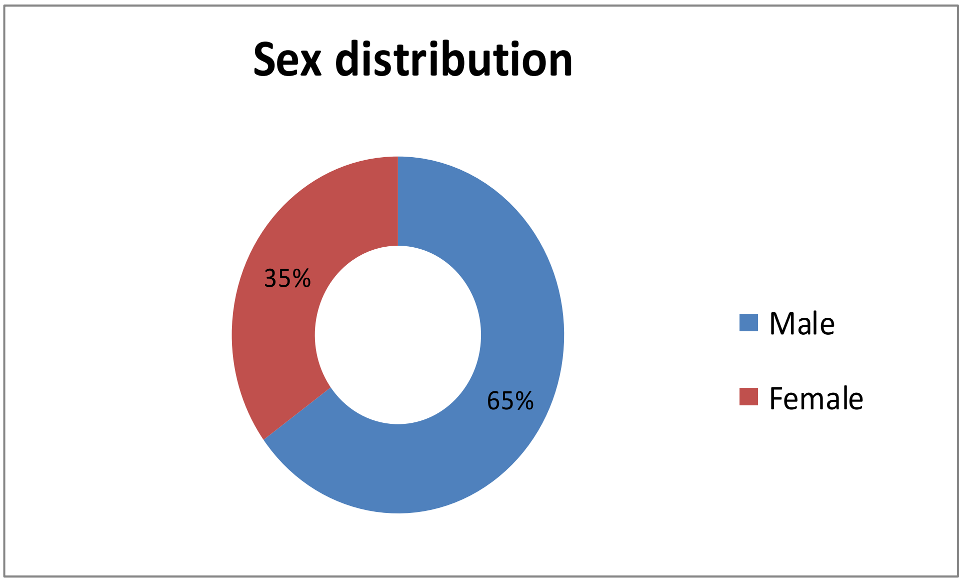

Sex distribution
35%
65%
Male
Female

Table III – SIDE DISTRIBUTION

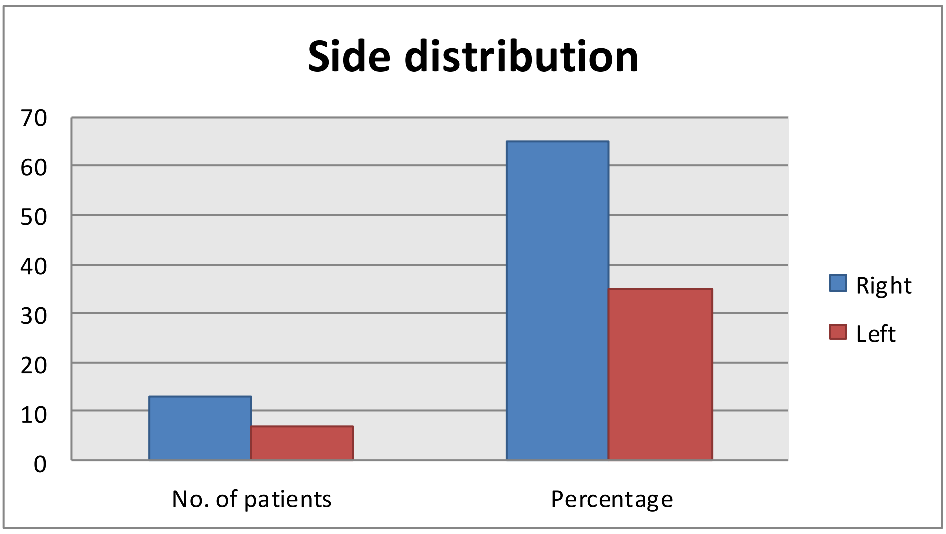
S. no	Side	No. of patients	Percentage
1	Right	13	65
2	Left	7	35

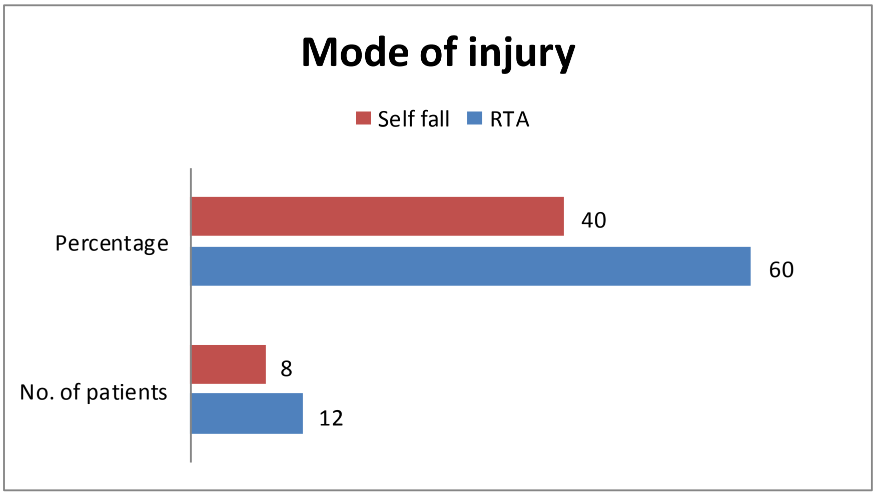
Table IV – MODE OF INJURY

S. no	Mode of injury	No. of patients	Percentage
1	RTA	12	60
2	Self-fall	8	40

Table V – CLOSED vs. OPEN FRACTURES

S. no	Closed/open	No. of patients	Percentage
1	Closed	15	75
2	Grade I compound	2	10
3	Grade II compound	3	15


Side distribution
70
60
50
40
30
20
10
0
No. of patients
Percentage
Right
Left


Mode of injury
Self fall
RTA
Percentage
40
60
No. of patients
8
12

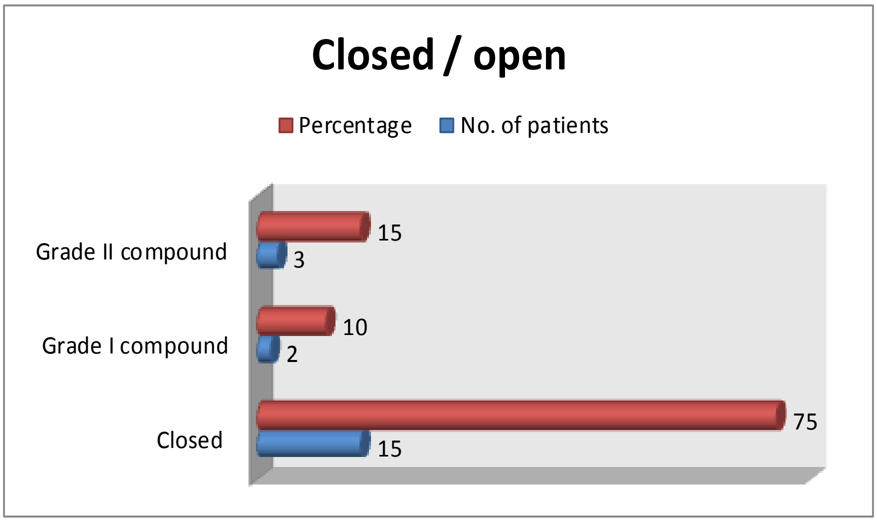
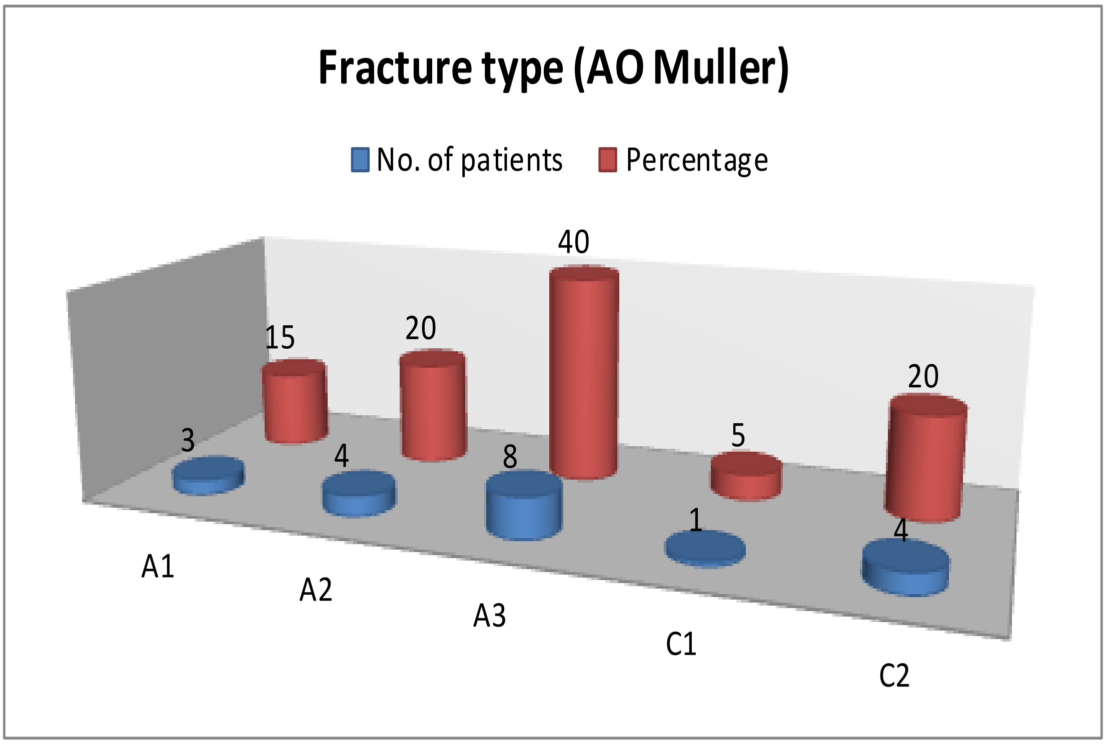

Closed / open
Percentage
No. of patients
Grade II compound
15
3
Grade I compound
10
2
Closed
75
15

Table VI – FRACTURE CLASSIFICATION

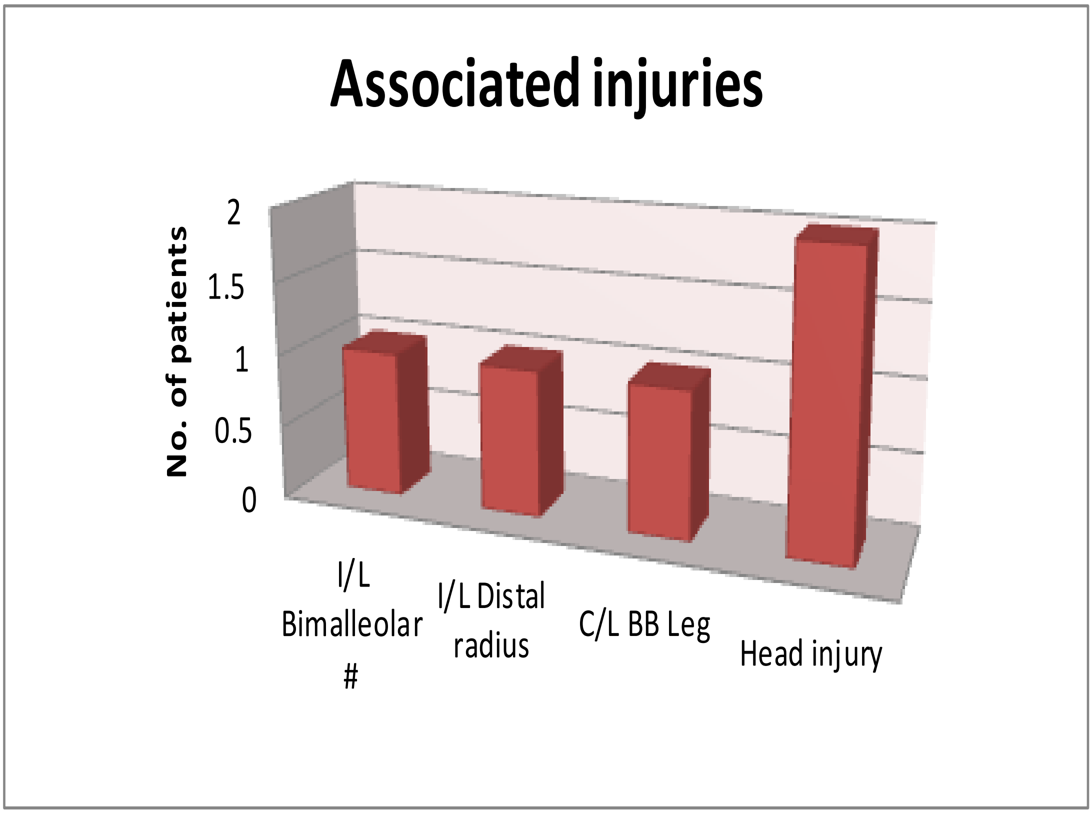
s. no	Fracture type (AO Muller)	No. of patients	Percentage
1	A1	3	15
2	A2	4	20
3	A3	8	40
4	C1	1	5
5	C2	4	20

Table VII – ASSOCIATED INJURIES

s.no	Associated injuries	No. of patients
1	I/L Bimalleolar #	1
2	I/L Distal radius	1
3	C/L BB Leg	1
4	Head injury	2



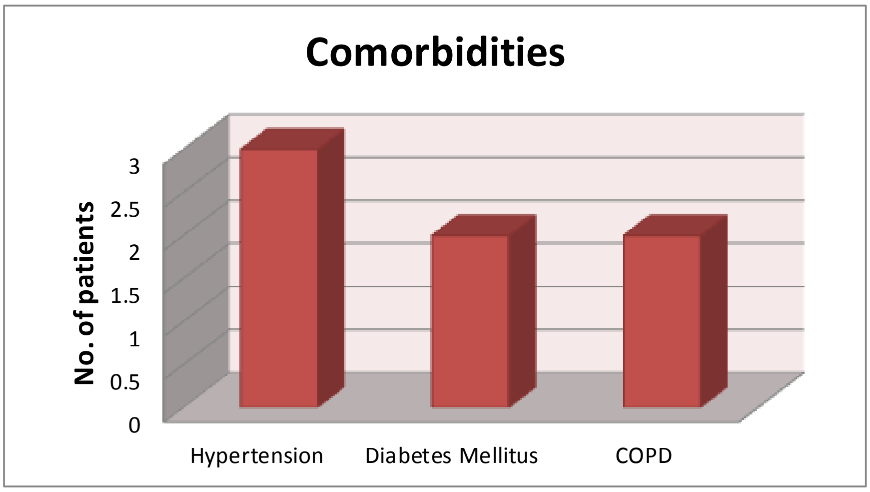
Fracture type (AO Muller)
No. of patients
Percentage
15
20
40
5
20
3
4
8
1
4
A1
A2
A3
C1
C2



Associated injuries
No. of patients
2
1.5
1
0.5
0
I/L Bimalleolar #
I/L Distal radius
C/L BB Leg
Head injury

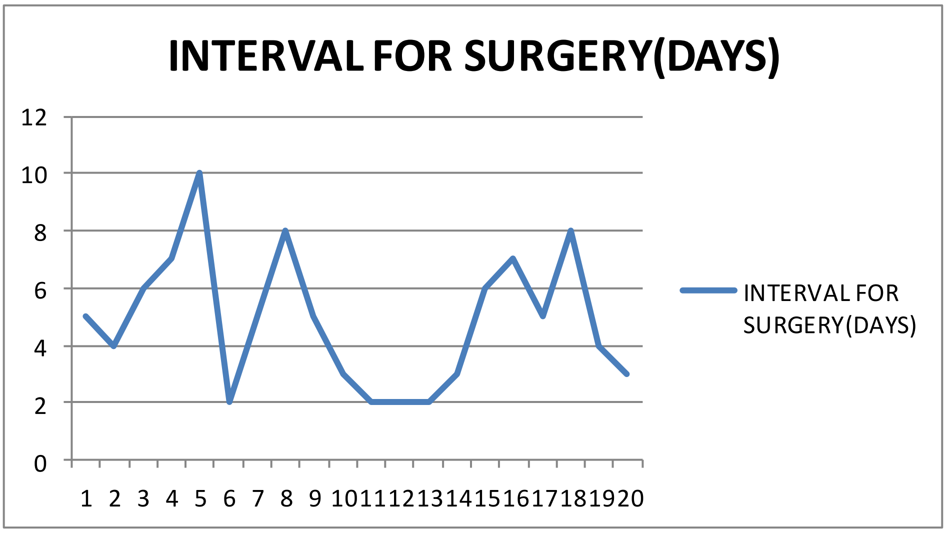
Table VIII – COMORBIDITIES

s.no	Comorbidities	No. of patients
1	Hypertension	3
2	Diabetes Mellitus	2
3	COPD	2



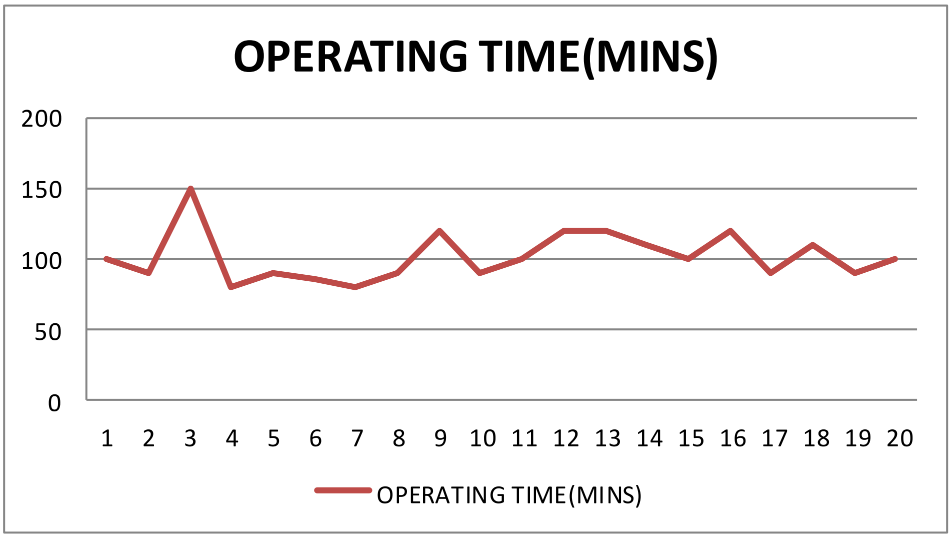
INTERVAL FOR SURGERY (DAYS)

The time interval between the date of injury to that of surgery ranges between a minimum of 2 days to the maximum 10 days (Mean = 5 days)



OPERATING TIME

The operating time varies between 80 minutes to 150 minutes. The mean operating time was 101 minutes (Mean = 101 min)

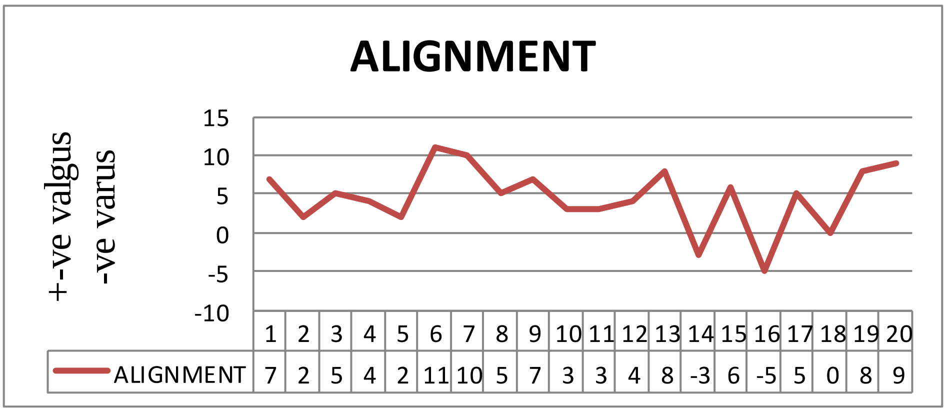


Length and rotation:

There was no obvious limb length discrepancy and rotational malalignment.

Axial alignment:

The axial alignment ranges between 11 degrees of valgus to 5 degrees of varus. (Mean = 4.5 degrees of varus)



The negative values indicate varus alignment.

TIME TO UNION

The time taken to achieve union ranges between minimum of 12 weeks to maximum of 20 weeks. (Mean = 15 weeks)

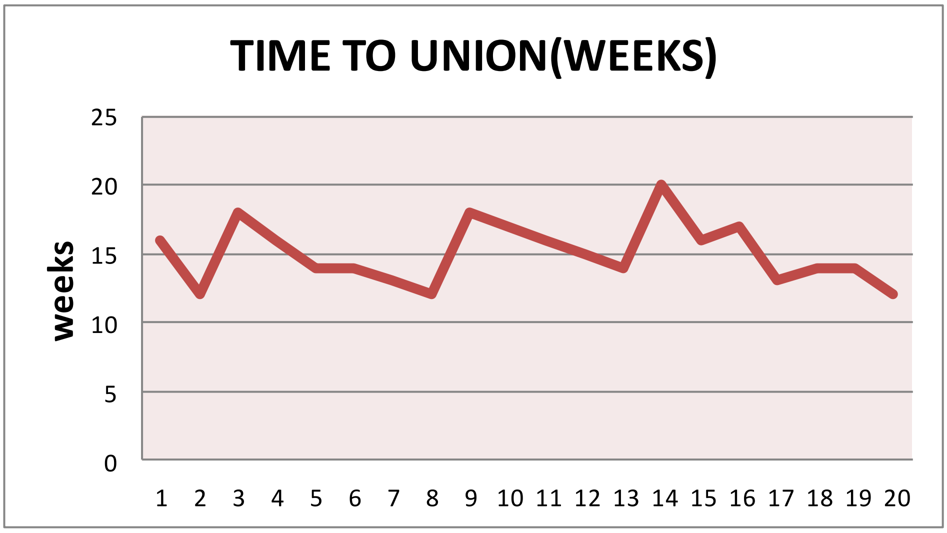


TABLE – IX RADIOLOGICAL ASSESSMENT OF UNION

S. no	*Hammer et al Grade*	No. of patients	Percentage
1	I	12	60
2	II	8	40

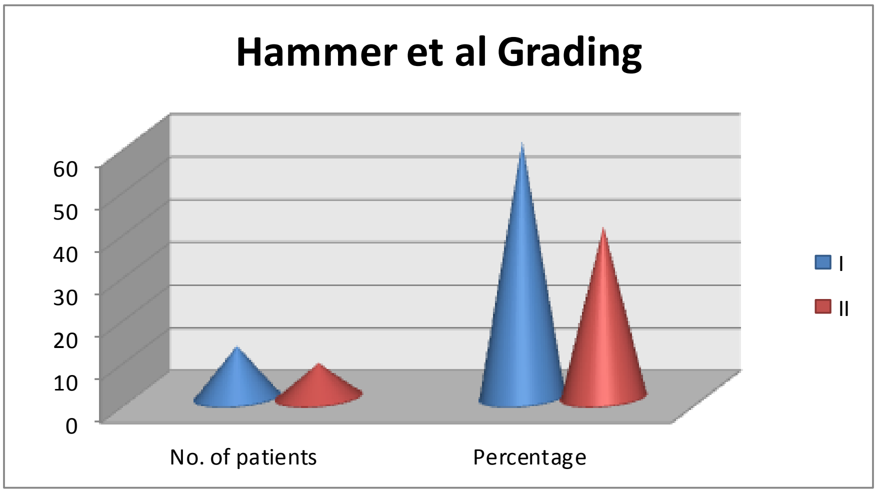


TABLE – X KNEE EXTENSION

S. no	KNEE EXTENSION	No. of patients	Percentage
1	Full	17	85
2	Extensor lag	3	15

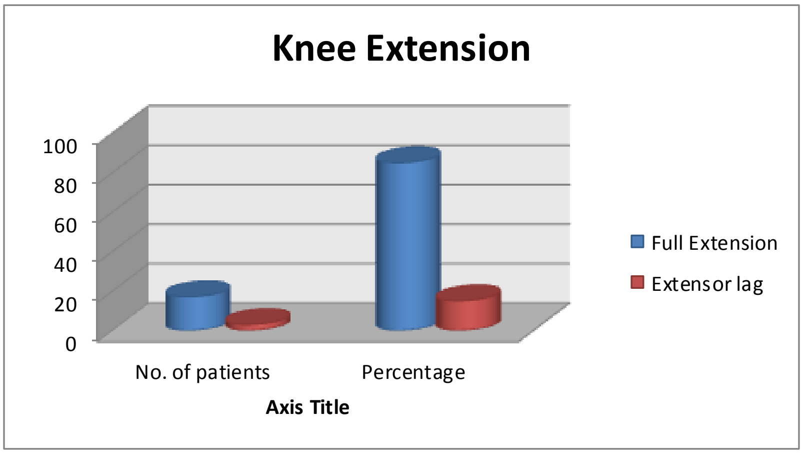
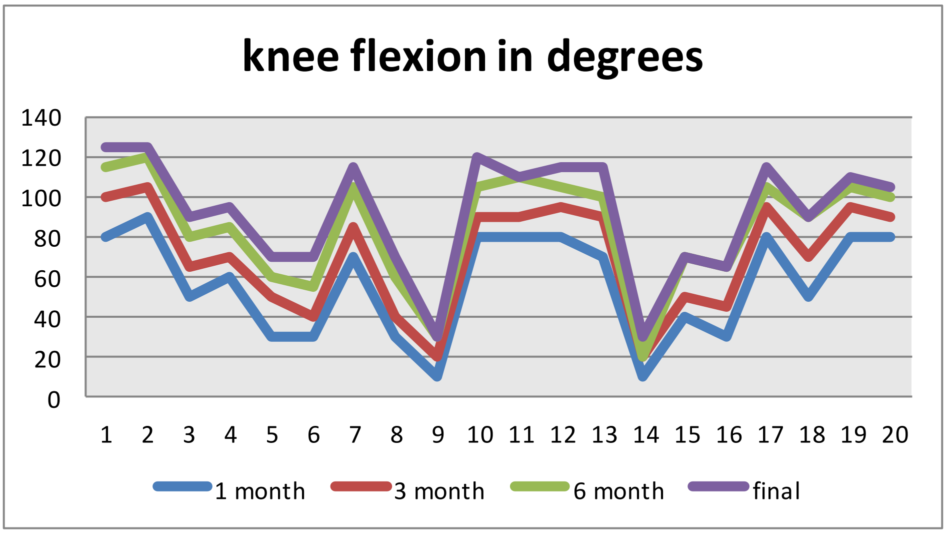


Table XI – KNEE FLEXION (DEGREES)

Follow up	Minimum flexion	Maximum flexion	Mean flexion
1month	10	90	56.5
3 month	20	105	70.25
6 month	20	120	84.25
Final	30	125	91.75



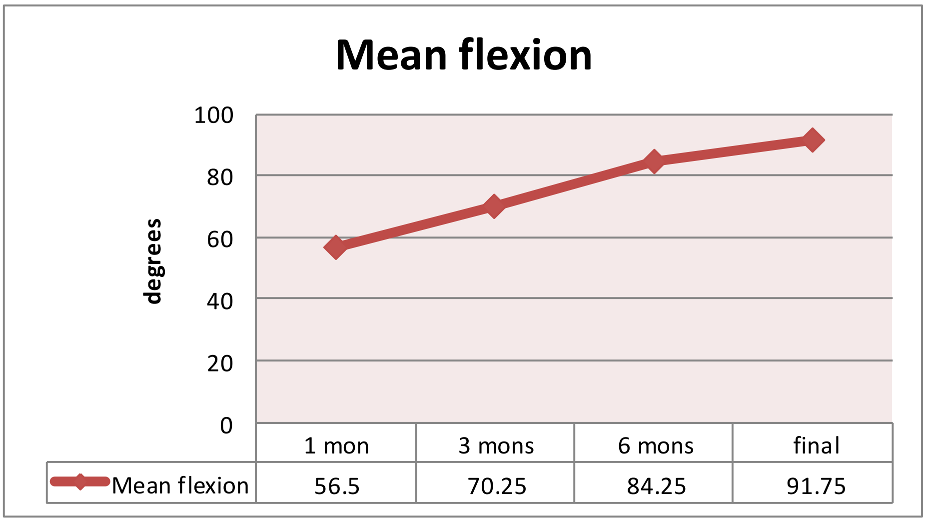
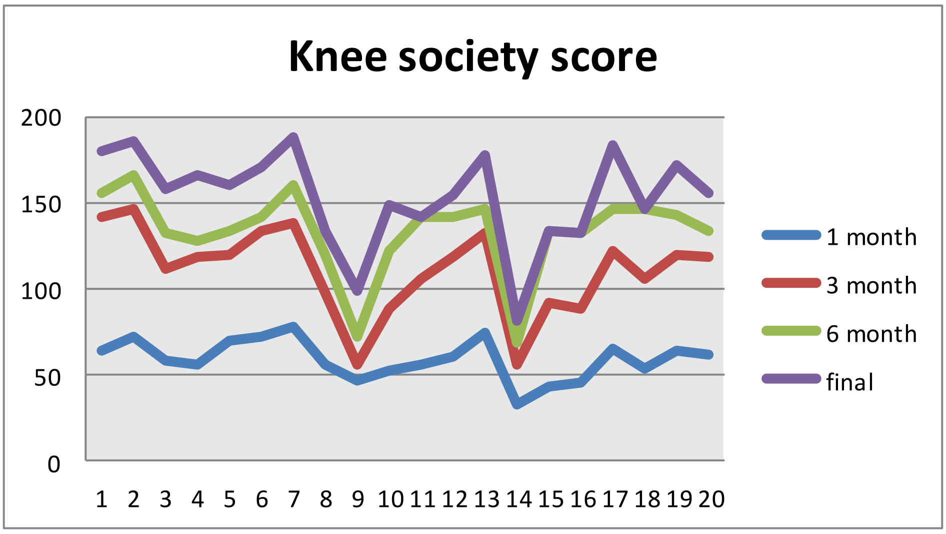
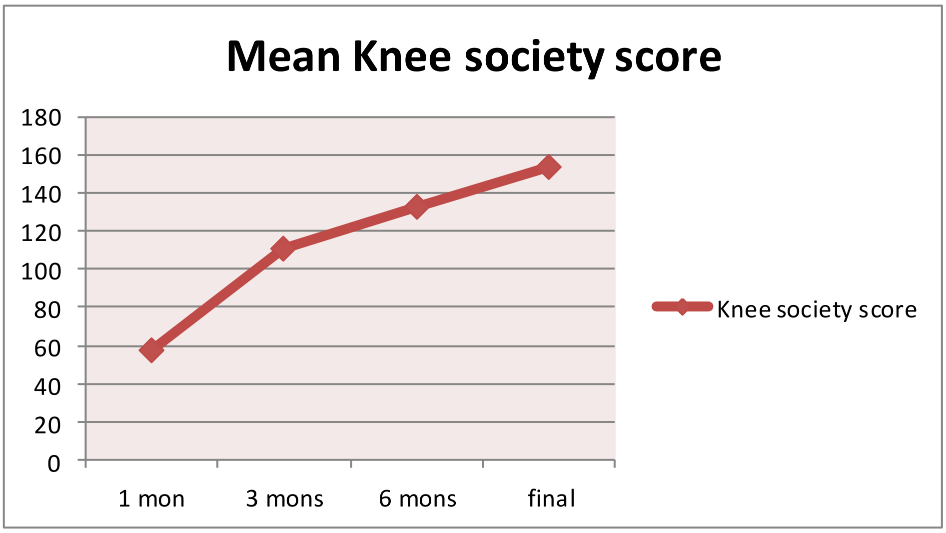


Table XII – KNEE SOCIETY SCORE (Total score 200)

Follow up	Minimum score	Maximum score	Mean score
1month	32	78	57
3 month	56	146	111
6 month	68	166	133
Final	81	188	153





COMPLICATIONS:

Among the 20 patients operated we had the following complications.

Loss of reduction:

We encountered one case of post-operative loss of reduction, for which open reduction and revision fixation done. The pictures are shown in illustration.

Deep vein thrombosis:

One case of post-operative DVT in an obese individual (high risk), confirmed with Doppler venography. After anticoagulant therapy, the patient recovers without any complications.

Infection:

We had a case of infection, noticed serosanguinous discharge on the 7^{th} post day at the distal incision site. Culture reports showed the growth of Staphylococcus aureus. After thorough lavage and i.v. vancomycin it settled uneventfully.

Knee stiffness:

We had three cases of knee stiffness, failed to improve even after continuous passive motion therapy. Two of them had fracture involving articular surface (type C2). Two cases are shown in illustration.

Varus:

Two patients had varus of 5^o and 3^o respectively. But these are within acceptable limits (< 5 deg of malalignment)

Reactive synovitis:

One patient had diffuse knee swelling at 2 months post op without any toxic features. Ultrasound of knee revealed diffuse synovial thickening with free fluid. Knee aspiration cytology and culture reports are normal. It settled uneventfully with Aspiration, compression bandage and rest.

TABLE XIII – COMPLICATIONS

s. no	Complications	No. of patients	Percentage
1	Loss of reduction	1	5
2	DVT	1	5
3	Infection	1	5
4	Knee stiffness	3	15
5	Reactive synovitis	1	5

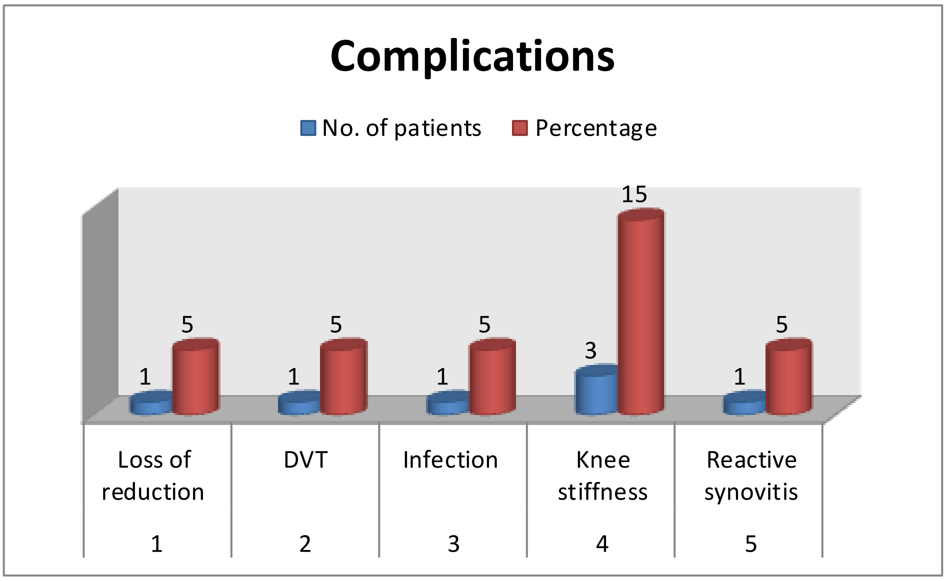
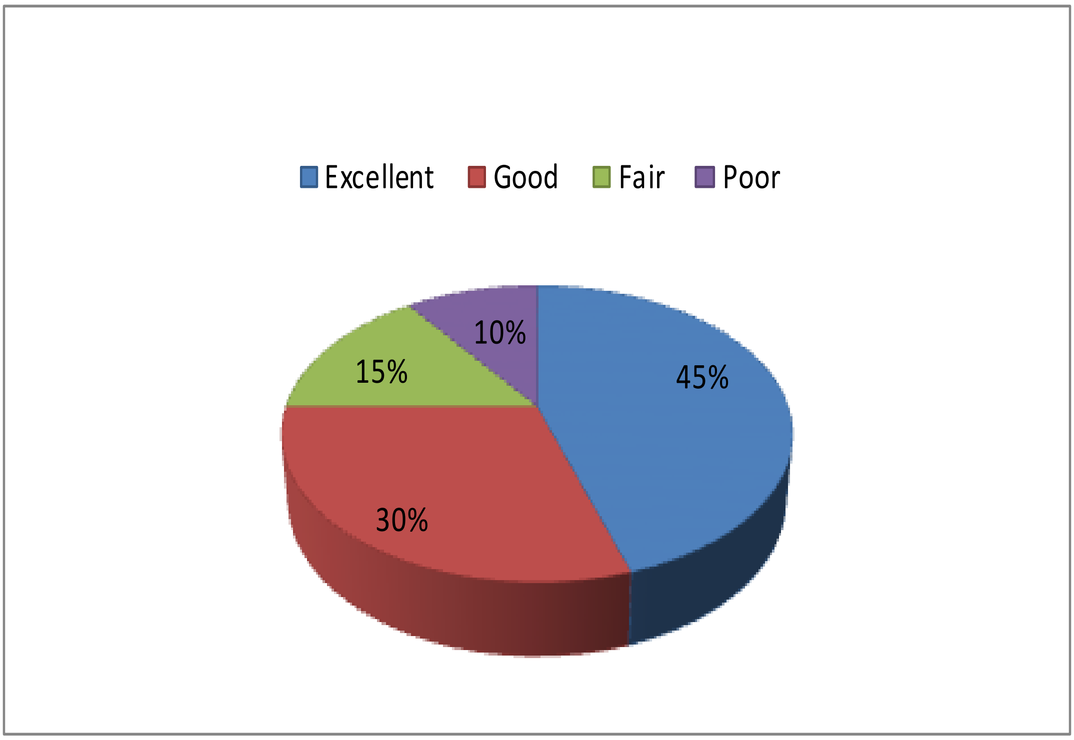


TABLE – XIV OUTCOME

S. no	OUTCOME	No.of patients	Percentage
1	Excellent	9	45
2	Good	6	30
3	Fair	3	15
4	Poor	2	10

OUTCOME



CASE ILLUSTRATIONS

CASE I:

60 year old female, sustained injury to her right thigh after an accidental fall.

Associated Injury	:	None
Associated Comorbidity	:	None
Time since injury	:	16 months
Muller's Type	:	Type A3 Muller
Closed /open	:	closed
Time Interval for Surgery	:	5 days
Time for Radiological Union	:	16 weeks
Knee Flexion Achieved	:	125^{o}
Knee society score	:	180
Functional Outcome	:	Excellent
Complications	:	None

X-RAY ILLUSTRATIONS

Pre operative – AP view

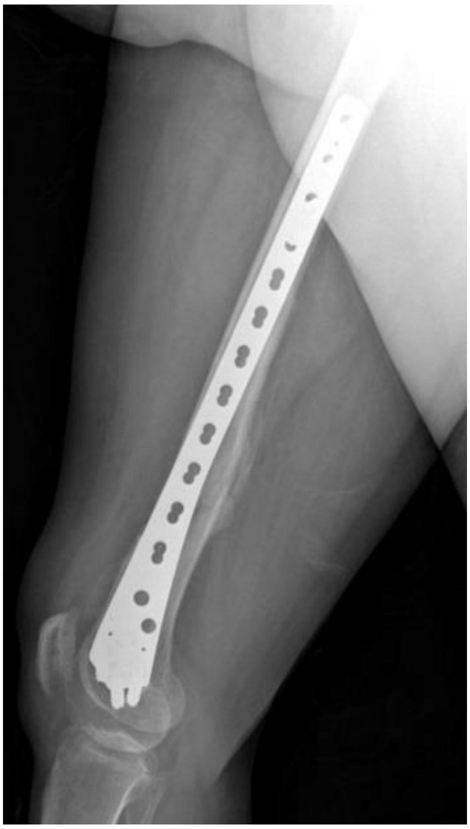
Pre operative – LAT view

Immediate post op –AP

Immediate post op -LAT

6 months post op - AP

6 months post op – LAT



16 months post op – AP

16 months post op - LAT

INTRA OPERATIVE PICTURE

Incision

Distal fixation

Proximal fixation

POST OPERATIVE FUNCTIONAL OUTCOME

Knee flexion

Knee extension & SLR

Squatting

Sitting cross legged

Case II:

22 year old male, sustained injury to his right thigh after a RTA.

Associated Injury	:	None
Associated Comorbidity	:	None
Time since injury	:	12 months
Muller’s Type	:	Type A1 Muller
Closed /open	:	closed
Time Interval for Surgery	:	4 days
Time for Radiological Union	:	12 weeks
Knee Flexion Achieved	:	125^{o}
Knee society score	:	186
Functional Outcome	:	Excellent
Complications	:	Reactive synovitis

X-RAY ILLUSTRATIONS

Pre operative – AP view

Pre operative – LAT view

Immediate post op –AP

Immediate post op -LAT

6 months post op - AP

6 months post op – LAT

14 months post op – AP

14 months post op - LAT

INTRA OPERATIVE PICTURE

Incision

Distal fixation

Proximal fixation

POST OPERATIVE FUNCTIONAL OUTCOME

Knee flexion

Knee extension & SLR

Squatting

Sitting cross legged

Case III:

40 year old male, sustained injury to his left thigh after a RTA.

Associated Injury	:	I/L Bimalleolar #
Associated Comorbidity	:	None
Time since injury	:	7 months
Muller's Type	:	Type A3 Muller
Closed /open	:	Closed
Time Interval for Surgery	:	5 days
Time for Radiological Union	:	13 weeks
Knee Flexion Achieved	:	115^{o}
Knee society score	:	188
Functional Outcome	:	Excellent
Complications	:	None

X-RAY ILLUSTRATIONS

Pre operative – AP view

Pre operative – LAT view

Immediate post op –AP

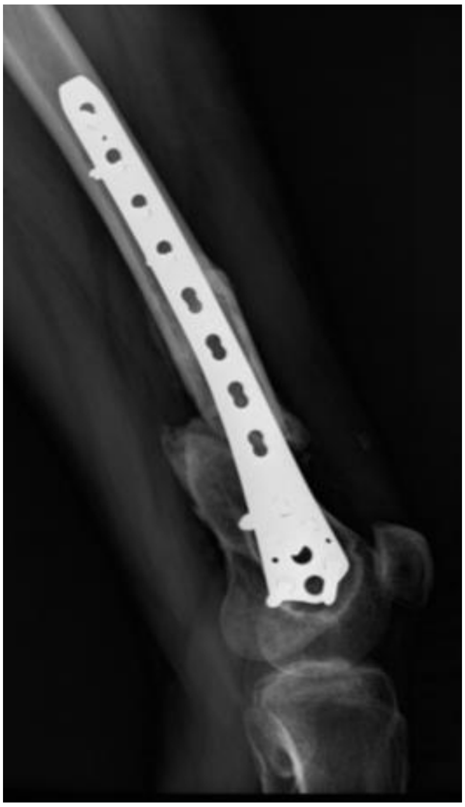
Immediate post op -LAT

3 months post op - AP

3 months post op – LAT

7 months post op – AP

7 months post op - LAT



INTRA OPERATIVE PICTURE

Incision | **Distal fixation** | **Wound closure**

POST OPERATIVE FUNCTIONAL OUTCOME

Knee flexion

Knee extension & SLR

Squatting

Sitting cross legged

Case IV:

65 year old male, sustained injury to his right thigh after a self-fall.

Associated Injury	:	None
Associated Comorbidity	:	COPD
Time since injury	:	10 months
Muller's Type	:	Type A3 Muller
Closed /open	:	Closed
Time Interval for Surgery	:	7 days
Time for Radiological Union	:	16 weeks
Knee Flexion Achieved	:	95^{o}
Knee society score	:	166
Functional Outcome	:	Excellent
Complications	:	None

X-RAY ILLUSTRATIONS

Pre operative – AP view

Pre operative – LAT view

Immediate post op –AP

Immediate post op -LAT

6 weeks post op - AP

6 weeks post op – LAT

10 months post op – AP

10 months post op - LAT

INTRA OPERATIVE PICTURE

Incision **Distal fixation** **Proximal fixation**

POST OPERATIVE FUNCTIONAL OUTCOME

Knee extension & SLR

Squatting

Sitting cross legged

Case V:

65 year old female, sustained injury to her right thigh after a self-fall.

Associated Injury	:	None
Associated Comorbidity	:	Hypertension
Time since injury	:	12 months
Muller's Type	:	Type A3 Muller
Closed /open	:	Closed
Time Interval for Surgery	:	6 days
Time for Radiological Union	:	18 weeks
Knee Flexion Achieved	:	90^o
Knee society score	:	158
Functional Outcome	:	Good
Complications	:	**Post-operative loss of reduction, open reduction and revision fixation done.**

X-RAY ILLUSTRATIONS

Pre operative – AP view

Pre operative – LAT view

Immediate post op –AP

Immediate post op -LAT

Revision post op - AP x rays **Revision post op – LAT**

12 months post op – AP **12 months post op - LAT**

INTRA OPERATIVE PICTURE

POST OPERATIVE FUNCTIONAL OUTCOME

Knee flexion

Knee extension & SLR

Knee flexion in sitting

COMPLICATION –KNEE STIFFNESS

Knee flexion –70^{o}

Knee flexion – 30 ^{o}

DISCUSSION

The evolution of management of distal femoral fractures has come a long way from totally conservative management in the 1960's to definitive surgical treatment at present. There is increasing incidence of comminuted distal femur fractures due high velocity motor vehicle accidents in younger population and increased life expectancy resulting in fractures following trivial fall due to osteoporotic bone. In both the groups our aim is to restore the function and near normal anatomy similar to the pre injury status.

There are many surgical alternatives for distal femur fractures, each with its own pearls and pitfalls. Many studies were conducted using different implants and techniques resulted in varying outcome and complications. After the introduction of locking compression plate (LCP) by AO in 2000, the trend is shifting towards it due its added advantages like,

- Providing both angular and axial stability
- Applied in both locking and compression mode
- Better hold in osteoporotic bone

Due to the changing concepts towards relative stability and biological fixation from absolute stability and rigid fixation, minimally invasive plate osteosynthesis (MIPO) technique evolved. Many studies proved better outcome with lesser morbidity than the conventional technique.

In our study involving 20 patients with 13 males and 7 females with mean age of 47 and the mean follow up period ranges between 6 month to 18 month(mean - 12 month). 15 patients had type A fracture and 5 patients had type C fracture and 25% of patients had open injuries.

The mean operating time was 100 minutes compared to 119 minutes by Yeap and Deepak et al [35]. The mean time to radiological fracture union was 15 weeks (range 12 -20 weeks) Which was comparable to 11 weeks by Kregor et al [30] , 14.3 weeks by Schandelmaier et al [28], 12 weeks by Fankhauser et al [34]and 18 weeks by Yeap and Deepak et al. [35]

The average knee flexion achieved was 92 degrees comparable to that of 103^{o} by Kregor et al [30], 104^{o} by Schandelmaier et al [28], 107^{o} by schutz et al [29], 101^{o} by Fankhauser et al [34] and 93^{o} by Kanabar et al. [36]

The scoring system used was knee society scoring and the mean score was 153 compared to the score of 131 by Fankhauser et al . With this system 45 % patient is having an excellent outcome, 30 % good, 15 % fair and 10 % with poor outcome.

The percentage of patients with good and excellent outcome was 75 % comparable to 87.5 % by Markmiller et al, 72.7 % by Yeap and Deepak et al.

The complications encountered are deep seated infection (n=1), post-operative loss of reduction which requires a revision surgery (n=1), deep vein thrombosis (n=1), Knee stiffness (n=3), varus malalignment (n=2), reactive synovitis (n=1).

The incidence of loss of reduction requiring a revision surgery was 5% comparable to 10 % by Markmiller et al, 9 % by Yeap and Deepak et al 7.9 % by Schandelmaier et al and 6 % by Schutz et al.

The infection rate in our study was 5 % comparable to 7 % by Schutz et al [(29)] and 3 % by Kregor et al. [(30)]

We had two cases of varus malalignment (< 5 deg) but within acceptable limits in contrast to 15 % by Markmiller et al and 13 % by Schandelmaier et al, both having significant malalignment (> 10 deg). These patients may require a long term follow up to evaluate the development of arthritis.

There was an incidence of 15 % knee stiffness (n =2) < 30^o and (n=1) 70^o and failed to show any improvement even after aggressive continuous motion therapy.

We had a complication of post op DVT and reactive synovitis, which settled uneventfully with symptomatic therapy. Union was achieved in all cases and bone grafting was not required in any of our cases.

Table XV

Comparison of results of fractures of distal femur treated with MIPO & LISS

Author	No.of cases	F/up months mean	Mean Time to union(wks)	Knee Flexion deg	complications			scoring system & mean score	excellent and good results %
					Infection %	Revision/ Failure %	Malalign %		
Kregor et al	66	9	11	103	3	1.5	4.5	-	-
Kanabar et al	17	12	17	93	-	11.7	6	-	-
Schutz et al	99	13.7	-	107	7	6	1	-	-
Markmiller et al	20	12	13.8	110	-	10	15	Lysholm	87.5
Schandelmaier et al	54	6	14.3	104	1.4	7.9	13	Neer	-
Yeap & Deepak et al	11	9.7	18	107	-	9	9	schatzker	72.7
our study	20	12	15	92	5	5	-	Kss Mean-153	75

CONCLUSION

- In our study, Minimally Invasive Plate Osteosynthesis (MIPO) technique using Locking Compression Plate (LCP) shows good to excellent results in terms of union and functional outcome.
- When operated within two weeks of injury, it was easier to achieve closed reduction. This decreases the operating time, blood loss and intra-operative morbidity.
- MIPO technique could results in satisfactory union and eliminates the need for bone grafting.
- The incidence of infection and post- operative morbidity was less compared to conventional open technique.
- LCP has a better hold in osteoporotic bone with less chances of failure.
- Inadequate fixation leads to loss of reduction, resulting in an open reduction and revision fixation.
- Long term follow up is necessary to study the development of arthritis in patients with varus/ valgus malalignment.
- From our study, we conclude that the Minimally Invasive Plate Osteosynthesis (MIPO) technique using Locking Compression Plate (LCP) will results in early post- operative rehabilitation, satisfactory union and good functional outcome. The chances of infection and implant failure are less. Proper patient selection and meticulous surgical techniques will give the best results.

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ANNEXURES

S.NO	NAME	AGE	SEX	SIDE	TYPE	TIME SINCE INJURY(MONS)	MODE OF INJURY	CLOSED/OPEN	ASSOCIATED INJURY	INTERVAL FOR SURGERY(DAYS)	COMORBIDITIES	OPERATING TIME(MINS)	Radiological union Hammer et al			TIME TO UNION(WKS)
													Fracture line	union	Gr	
1	APK	60	FEMALE	RIGHT	A3	16	SELF FALL	CLOSED	NIL	5	NIL	100	obliterated	achieved	I	16
2	RJA	22	MALE	RIGHT	A1	14	RTA	CLOSED	NIL	4	NIL	90	obliterated	achieved	I	12
3	ADL	65	FEMALE	RIGHT	A3	12	SELF FALL	CLOSED	NIL	6	HT	150	obliterated	achieved	I	18
4	RGL	65	MALE	RIGHT	A3	10	SELF FALL	CLOSED	NIL	7	COPD	80	Barely discernible	achieved	II	16
5	ABK	43	MALE	LEFT	C2	12	RTA	OPEN GR 2	NIL	10	NIL	90	Barely discernible	achieved	II	14
6	SRK	26	MALE	RIGHT	C2	9	RTA	OPEN GR 2	NIL	2	NIL	85	Barely discernible	achieved	II	14
7	PDM	40	MALE	LEFT	A3	7	RTA	CLOSED	I/L BIMALLEOLAR #	5	NIL	80	Barely discernible	achieved	II	13
8	SUR	21	MALE	LEFT	A3	12	RTA	OPEN GR 1	NIL	8	NIL	90	obliterated	achieved	I	12
9	DPL	68	MALE	RIGHT	C2	13	SELF FALL	CLOSED	NIL	5	DM	120	obliterated	achieved	I	18
10	JLX	60	FEMALE	RIGHT	A2	7	SELF FALL	CLOSED	NIL	3	NIL	90	obliterated	achieved	I	17
11	KML	65	FEMALE	RIGHT	A2	6	SELF FALL	CLOSED	I/L DISTAL RADIUS	2	HT	100	obliterated	achieved	I	16
12	KMS	62	FEMALE	RIGHT	A3	16	SELF FALL	CLOSED	NIL	2	DM	120	obliterated	achieved	I	15
13	SNK	35	MALE	RIGHT	A2	18	RTA	OPEN GR 2	NIL	2	NIL	120	obliterated	achieved	I	14
14	NLV	80	FEMALE	RIGHT	A3	18	SELF FALL	CLOSED	NIL	3	DM/HT	110	Barely discernible	achieved	II	20
15	CHN	64	MALE	RIGHT	C2	6	RTA	CLOSED	C/L BB LEG	6	NIL	100	Barely discernible	achieved	II	16
16	KRS	58	MALE	LEFT	A3	6	RTA	CLOSED	HEAD INJURY	7	COPD	120	Barely discernible	achieved	II	17
17	WLF	35	MALE	RIGHT	A2	16	RTA	CLOSED	NIL	5	NIL	90	obliterated	achieved	I	13
18	VNK	21	MALE	LEFT	C1	6	RTA	OPEN GR 1	HEAD INJURY	8	NIL	110	Barely discernible	achieved	II	14
19	KLY	31	MALE	LEFT	A1	17	RTA	CLOSED	NIL	4	NIL	90	obliterated	achieved	I	14
20	VIN	20	FEMALE	LEFT	A1	15	RTA	CLOSED	NIL	3	NIL	100	obliterated	achieved	I	12

S.NO	NAME	KNEE FLEXION(DEG)				EXTENSOR LAG(DEG)	ALIGNMENT(VALGUS)	KNEE SOCIETY SCORE(200)				COMPLICATIONS	OUTCOME
		1 mon	3 mons	6 mons	final			1 mon	3 mons	6 mons	final		
1	APK	80	100	115	125	nil	7 DEG	64	141	156	180	NIL	EXCELLENT
2	RJA	90	105	120	125	10	2 DEG	72	146	166	186	REACTIVE SYNOVITIS	EXCELLENT
3	ADL	50	65	80	90	nil	5 DEG	58	112	132	158	LOSS OFREDUCTION	GOOD
4	RGL	60	70	85	95	15	4 DEG	56	118	128	166	NIL	EXCELLENT
5	ABK	30	50	60	70	nil	2 DEG	70	120	133	160	NIL	EXCELLENT
6	SRK	30	40	55	70	nil	11 DEG	72	134	141	171	NIL	EXCELLENT
7	PDM	70	85	105	115	nil	10 DEG	78	138	160	188	NIL	EXCELLENT
8	SUR	30	40	60	70	nil	5 DEG	56	98	120	133	KNEE STIFFNESS	FAIR
9	DPL	10	20	30	30	nil	7 DEG	46	56	72	99	DVT/KNEE STIFFNESS	POOR
10	JLX	80	90	105	120	nil	3 DEG	52	88	122	149	NIL	GOOD
11	KML	80	90	110	110	nil	3 DEG	56	106	141	141	NIL	GOOD
12	KMS	80	95	105	115	nil	4 DEG	60	118	141	154	NIL	GOOD
13	SNK	70	90	100	115	nil	8 DEG	74	132	146	178	NIL	EXCELLENT
14	NLV	10	20	20	30	nil	-3 DEG	32	56	68	81	KNEE STIFFNESS	POOR
15	CHN	40	50	70	70	10	6 DEG	43	92	134	134	INFECTION	FAIR
16	KRS	30	45	65	65	nil	-5 DEG	45	88	132	132	NIL	FAIR
17	WLF	80	95	105	115	nil	5 DEG	65	122	146	183	NIL	EXCELLENT
18	VNK	50	70	90	90	nil	0 DEG	54	106	146	146	NIL	GOOD
19	KLY	80	95	105	110	nil	8 DEG	64	120	143	172	NIL	EXCELLENT
20	VIN	80	90	100	105	nil	9 DEG	61	118	134	156	NIL	GOOD

Knee Society Score		
Knee Society Rating	Points	Patient Score
Pain (50 points)		
None	50	= 50
Mild or occasional	45	
Stairs only	40	
Walking and stairs	30	
Moderate occasional	20	
Moderate continual	10	
Severe		
Range of Motion5 degrees = 1 point	25	= 25
	0	
Anteroposterior Stability (maximum movement in any postion)		= 10
<5mm	10	
5-10mm	5	
10mm	0	
Medial lateral Stability		= 15
<5 degrees	15	
6-9 degrees	10	
10-14 degrees	5	
15 degrees	0	
Deductions		= 0
Flexion contracture		
5-10 degrees	2	
10-15 degrees	5	
16-20 degrees	10	
>20 degrees	15	
Extension lag		
<10 degrees	5	
10-20 degrees	10	
>20 degrees	15	
Alignment		
5-10 degrees	0	
0-4 degrees	3 points each	
11-15 degrees	3 points each	
Other		
Function Rating		
Walking		= 50
Unlimited	50	
>10 blocks	40	
5-10 blocks	30	
<5 blocks	20	
Housebound	10	
Unable	0	
Stairs		= 50
Normal up and down	50	
Normal up; down with rail	40	
Up and down with rail	30	
Up with rail; unable down	15	
Unable	0	
Deductions		= 0
Cane	5	
Two canes	10	
Crutches or walker	20	
Score		
Knee Rating= 100		
Function= 100		

PATIENT PROFORMA

Name	:	
Age / Sex	:	
IP number	:	
Address	:	
Contact Number	:	
Email id	:	
Date of Admission	:	
Date of Surgery	:	
Date of Discharge	:	
Occupation	:	
Education	:	
Socioeconomic Status	:	
Diagnosis	:	
Procedure Done	:	
Outcome	:	I – excellent II – good III – fair IV - poor

HISTORY:

1. Mode of injury : Road traffic accident / Fall at home / Fall from height / Assault

2. Presenting complaints :

a. Pain – site / duration

b. Swelling – site / extent

c. Deformity

d. Disturbances in function – movements

e. Other associated injuries – head injury / limb injuries / spine injuries

Comorbid illnesses :

Diabetes mellitus		Hypertension		Coronary heart disease	
Renal disorder		Seizures /Neurological disorder		Hepatic disorder	
Dyslipedemia		Endocrine disorder		Tuberculosis	
Bronchial Asthma		Chronic Obstructive lung diseases		Neoplastic disorders	

3. Drug history : Steroids / Disease modifying anti-rheumatoid drugs / Immunosuppresants

PAST HISTORY:

- Any similar injuries
- Previous surgeries or hospitalisations
- Any major illnesses

PERSONAL HISTORY:

Diet	Vegetarian / Mixed
Marital Status	Married / Single
Bowel and Bladder habits	Regular / Altered
Habits	Smoking / Alcohol / Tobacco / Drug Addictions / Others

OBSTETRIC & GYNAECOLOGY HISTORY:

TREATMENT HISTORY:

FAMILY HISTORY:

CLINICAL EXAMINATION:

GENERAL EXAMINATION:

- ☞ Appearance :
- ☞ Built :
- ☞ Pallor :
- ☞ Icterus :
- ☞ Cyanosis :
- ☞ Clubbing :
- ☞ Pedal Edema :
- ☞ Lymphadenopathy :

VITALS:

1. Pulse :
2. BP :
3. Respiratory rate :
4. Temperature :

SYSTEMIC EXAMINATION :

- ☞ Cardiovascular system :
- ☞ Respiratory system :
- ☞ Abdomen :

REGIONAL EXAMINATION

RIGHT / LEFT THIGH &KNEE

Swelling :

Tenderness :

Deformity :

Abnormal mobility :

Crepitus

Distal pulse

Toe /ankle extension

OTHER INJURIES

X – RAY FINDINGS:

Xray R/L femur with knee :

Other xrays

Ct scan

INVESTIGATIONS

Hb%		TC		DC	P L B E M
ESR		BT/CT		RBS	
UREA		S.CREATININE		ELECTROLYTES	Na^{+} K^{+}
HBsAg		HIV		VDRL	
CXR		ECG		URINE ROUTINE ALBUMIN SUGAR DEPOSITS	
Blood G & T					

FINAL DIAGNOSIS:

INITIAL TREATMENT GIVEN:

PLANNED SURGERY :

PROCEDURE NOTES

POST OP PERIOD

CLINICAL FINDINGS :

FOLLOW UP (After discharge)	ROM*	KSS**			Limb length	Varus/valgus alignment	ADVICE
		objective	functional	total			
FIRST WEEK							
SECOND WEEK							
FIRST MONTH							
THIRD MONTH							
SIXTH MONTH							
I YEAR							

RADIOLOGICAL OUTCOME :

FOLLOW UP (After discharge)	Implant position	Fracture reduction	Fracture healing		Hammer et al Grade	ADVICE
			callus	union		
FIRST WEEK						
SECOND WEEK						
FIRST MONTH						
THIRD MONTH						
SIXTH MONTH						
1 year						

Outcome :

I – excellent

II – good

III – fair

IV – poor

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம்:கீழ் தொடை பகுதியில் உள்ள எலும்பு முறிவிற்கு உலோக தகட்டை சிறு கீறலின் மூலம் பொருத்தும் அறுவை சிகிச்சையின் பயன்களை அறியும் ஆய்வறிக்கை

ஆராய்ச்சி மையம்: அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை

நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✓) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐
2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐
3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாராய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐
4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ ஏற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐
5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐
6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

PATIENT CONSENT FORM

Study detail: "A SHORT TERM ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL FEMORAL FRACTURES FIXED WITH LOCKING COMPRESSION PLATES BY MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS TECHNIQUE (MIPO) "

Study centre : KILPAUK MEDICAL COLLEGE, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

I hereby consent to participate in this study. ☐

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address: place date

Signature of investigator :

Study investigator's Name : place date

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.1223/ME-1/Ethics/2013 Dt:07.03.2013.
` CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on short term analysis of functional and radiological outcome of distal femoral fractures fixed with locking plates by minimally invasive plate osteosynthesis technique (MIPO)" for Project work. submitted by Dr. Sivaprasath.J, MS (Ortho), PG Student, Dept. of Ortho, Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

19/4/13
CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,Chennai
19/4

GOVT. KILPAUK MEDICAL COLLEGE
19 APR 2013
Kilpauk, Chennai-10.